

# MANUAL OF NUTRITION

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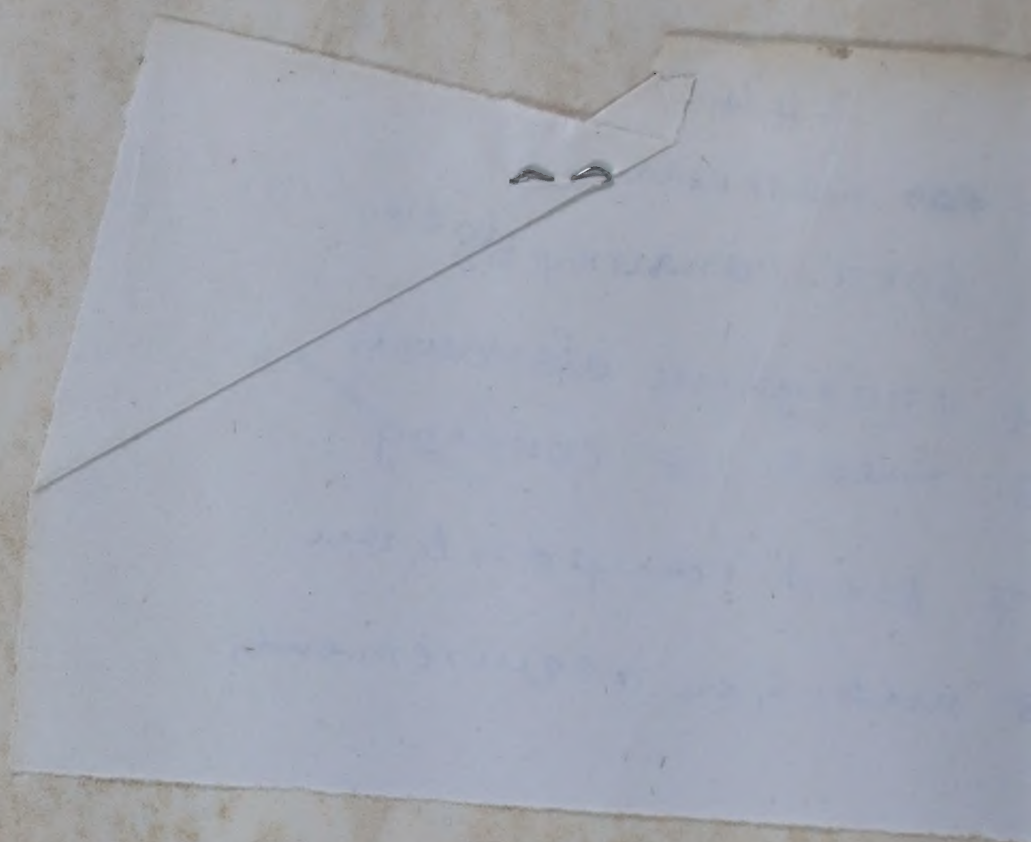
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MINISTRY OF FOOD

# MANUAL OF NUTRITION



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## PREFACE

THE FIRST EDITION of this Manual of Nutrition was written in 1945 by Dr. Magnus Pyke, then a member of the Scientific Adviser's Division of the Ministry of Food. A second edition was published in 1947. The rapid advance of research in nutrition has now necessitated not only revision of many of the original tables but also a re-writing of much of the text. This third edition, prepared by present members of the Scientific Adviser's Division of the Ministry, differs substantially from the first and second editions.

Nutrition is the process of assimilating food, and the principles of good nutrition are of course applicable to all kinds of feeding in every country, no matter whether the food be prepared and served at home, in school, in canteen or restaurant or elsewhere. The science of nutrition is complex, and therefore not to be picked up easily from posters, popular lectures, broadcasts and films. A working knowledge of the subject demands careful study, and it is the purpose of this Manual to supply information sufficient for such a knowledge. Designed to meet the needs of the caterer, the text was originally intended for use in teaching the principles of nutrition to people already possessed of practical knowledge of cooking and catering; but its range of usefulness could obviously be extended to teachers of domestic science and their students and pupils, and to all who were in any way concerned with public health. It has already been found valuable by many of these, and by others who realise that an understanding of the scientific basis of good feeding should be part of the everyday knowledge of an educated community.

Presenting, therefore, a volume of complex material in simple form, the Manual can be correctly interpreted only by an instructor who has studied nutritional science and is competent to amplify the information given in the text. This text is divided in four parts; it is suggested that each part may form the basis of three lectures plus some practical work. The questions included at the end of each section have been found useful both in the classroom and as homework.

No attempt has been made to teach chemistry, physiology, or any other basic subject upon which the science of nutrition is founded. Therefore those who master the material set out in the following pages cannot claim to be specialists in nutrition or qualified dietitians. They should, however, have grasped the underlying principles of nutrition and be able to appreciate the fundamental importance of the subject to good catering. For those who wish to study nutrition more scientifically, a list of text-books and specialist journals is included at the end of the Manual.

# SCHEME FOR LECTURES AND PRACTICAL WORK

## PART I

### *Lecture 1*

GENERAL INTRODUCTION TO NUTRITION	p. 1
CARBOHYDRATES	p. 3
PRACTICAL	

Examine and taste glucose, lactose, maltose and sucrose. Examine under the microscope (if the students have had previous experience with this instrument) starch from potato, flour, cornflour, rice, etc., cooked and raw. Demonstrate grams and ounces and calculate weights in grams and ounces.

### *Lecture 2*

FATS	p. 5
PROTEINS	p. 7
PRACTICAL	

Demonstrate by dissection the amount of fat in two pieces of meat. Demonstrate saponification of animal fat and resistance to saponification of mineral wax. Compare egg albumen, gelatin, gluten, casein and dried meat. Compare dried milk and flour, etc.

### *Lecture 3*

FOOD CONSUMPTION AND PHYSICAL WORK	p. 10
PRACTICAL	

Answer the questions given at the end of Part I

## PART II

### *Lecture 4*

INORGANIC ELEMENTS	pp. 16, 18, 20
CALCIUM AND PHOSPHORUS	pp. 18, 19
IRON	p. 20
PRACTICAL	

Weigh out amounts of cheese, milk, watercress, cabbage, potato and flour each containing 100 mg. of calcium. Weigh out 250 mg. of chalk which also contains 100 mg. of calcium. Compare the weights of foods providing 100 mg. of calcium with amounts containing 200 mg. of phosphorus. Weigh out amounts of meat, bread and potato each containing 1 mg. of iron.

### *Lecture 5*

VITAMIN A	p. 21
VITAMINS D, E, K	p. 23
PRACTICAL	

Compare the amounts of vitamin A by weighing the ingredients of the two meals provided: (a) Meat, potato, cabbage, steamed pudding; (b) Bread, butter, cheese, milk, tomato.

## Lecture 6

### THE VITAMIN B GROUP OF NUTRIENTS VITAMIN C PRACTICAL

p. 24  
p. 27

Compare the amounts of vitamin B<sub>1</sub>, riboflavin, and nicotinic acid, obtained in 4 oz. of bread, oatmeal, peanuts, dried peas and milk. Weigh out sufficient potato, cabbage, lettuce, orange and apple to provide 30 mg. of vitamin C.

Answer the questions given at the end of Part II.

## PART III

## Lecture 7

### THE DIGESTION OF FOODS, THE ABSORPTION OF NUTRIENTS AND THEIR FATS IN THE BODY PRACTICAL

p. 30

Examine the dissected digestive tract of a pig. Compare the result of a piece of meat shaken up in pepsin solution, bread shaken up in saliva and fat shaken up with bile salts with corresponding treatment with water alone.

## Lecture 8

### NUTRITIONAL REQUIREMENTS PRACTICAL

p. 35

Calculate the complete nutritional value of two diets provided, by weighing their ingredients and make suggestions for improving them: (a) for a coal miner; (b) for a child of 10 years old.

## Lecture 9

### THE COMPOSITION OF FOOD PRACTICAL

p. 39

Answer the questions given at the end of Part III.

## PART IV

## Lecture 10

### COOKING PRACTICAL

p. 44

Calculate complete nutritional value of a cake by weighing the ingredients provided. Weigh out amounts of (a) the baked cake and bread; (b) boiled potatoes and chips to provide 300 Calories. Weigh amounts of boiled cabbage and salad both containing 30 mg. of vitamin C.

## Lecture 11

### MEALS PRACTICAL

p. 47

With the ingredients provided, put together a meal containing 1,000 Calories, 25 g. or more of protein, 300 mg. or more of calcium, 2,000 i.u. of vitamin A and at least 30 mg. of vitamin C. Calculate how much food would be needed to supply 500 such meals.

## Lecture 12

### DIETS PRACTICAL

p. 51

Answer the questions at the end of Part IV.



# MANUAL OF NUTRITION

## PART ONE

### CHAPTER I : GENERAL INTRODUCTION

THE FOODS EATEN by the peoples of the world may vary widely between country and country and between different districts of the same country, but any diet must contain sufficient foods of chemically different kinds if the health of the eater is not to suffer. The science of nutrition includes the study of those principles by which the sufficiency of diet can be measured. Anyone whose business it is to provide meals should know the fundamentals of nutrition and thereby be able to estimate the value of the food provided.

Before any details are discussed the following three definitions are necessary :

1. The science of *nutrition* entails the study of all processes of growth, maintenance and repair of the living body which depend upon the intake of food.

2. *Life*, here considered as the state of continual change and functional activity which distinguishes animals (and vegetables) from inanimate matter, is from a nutritional point of view a chemical process in which an organism draws from food the material and energy necessary for its growth, continuity of existence, and power of reproduction.

3. *Food* is, for the purposes of this text, any solid or liquid which when swallowed can provide the human body with material enabling it to function in one or more of the following ways :

- (a) production of heat or other manifestation of energy ;
- (b) growth, repair or reproduction ;
- (c) regulation of the production of energy or of the processes of growth, repair and reproduction. The foods in this group are known as the protective foods because they help to maintain health.

Of the very large number of foodstuffs from which a diet may be chosen, each qualifies to rank as a food (according to the above definition) because it contains one or more of the groups of materials listed below. These components which give a substance its right to be called a food are known as *nutrients*.

#### THE NUTRIENTS OF WHICH FOODS ARE COMPOSED

1. CARBOHYDRATES provide the body with energy and may also be converted into fat.
2. FATS provide energy and may also form body fat.
3. PROTEINS provide material for growth and repair of body tissues. They also provide energy and sometimes can be converted into fat.
4. MINERAL SUBSTANCES provide material for growth and repair and for regulation of body processes.
5. VITAMINS AND OTHER ACCESSORY SUBSTANCES regulate the body processes.

Water and the oxygen provided by air are necessary for animal life, but although it could be argued that they should be included in the list given above, it is not proposed to classify them as nutrients.

A few foods contain only one nutrient ; most foods are mixtures and contain several nutrients.

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The need of the body for water is second in importance only to its need for air. Approximately two-thirds of the total weight of the body is made up by water; water transports food to the body cells and carries away the waste products. The body is continually balancing the amount of water taken in the diet with the amount excreted. If too little is drunk, dehydration occurs; if too much is drunk, the body can get rid of the excess through the kidneys. At least  $1\frac{1}{2}$  pints of water or other fluid should be drunk every day.

### MALNUTRITION AND UNDER-NUTRITION

The proper maintenance of nutrition in an individual depends on provision of appropriate amounts of all the nutrients. A wrong proportion between these amounts results in a condition of *malnutrition*. An insufficient total amount of nutrients results in *under-nutrition*, of which condition the extreme degree is *starvation*.

The stunting of a child's growth because of lack of protein or other nutrient, or cracking and ulceration of an adult's lips because of a shortage of vitamins, may be described as resulting from malnutrition as truly as excessive fatness results from consumption of too much food.

### CHEMICAL PROCESS OF LIVING

It has already been said that the body derives from food its energy and its material for growth and self-maintenance. Wheat can be treated in a laboratory so that it will combine with oxygen from the air to produce measurable heat, that is, energy. This property of wheat has been exploited in times of glut, when the grain has been used for fuel in railway engines. When wheat is eaten, an almost identical amount of energy in the form of heat is produced; in the body the final chemical products are the same as those obtained in the laboratory or the engine. The chemical apparatus of the body differs of course from that of laboratory or engine, but the result is the same. Again, the process by which petrol enables the wheels of a car to turn is chemical; so is the process by which food empowers a muscle to move a limb.

### MULTIPLE FUNCTION OF FOOD

Food has been defined overleaf as not only providing energy but also supplying material for bodily growth and regulation of bodily activity. Thus iron, even in the form of rust from a cooking-pot, is a food; it may serve to repair worn-out elements in the blood. Nevertheless the given definition of food is imperfect and must be used with discretion. For example, alcohol is a food because it can provide energy, but it is also a narcotic drug. Small amounts of iodine rank as food, for iodine normally regulates a function of the body; but iodine in quite small excess is a poison. Substances which can regulate bodily function, but are simply drugs, are excluded by the definition from classification as foods; but the two examples alcohol and iodine—there are many others—illustrate the difficulty of deciding what is a food and what is not. Salt, which helps to repair the body and regulate its functions, is a food; pepper is not. Tea, it may be claimed, regulates bodily processes, but the active drug in tea is not a substance which normally acts as a regulator. Tea provides no energy and no material for growth or repair; therefore tea is not a food. The milk and sugar usually drunk with tea are of course foods.

### STANDARD MEASUREMENTS OF AMOUNT

To calculate the amount of different nutrients in food it is necessary to use standard units, of which some of the more common are grams, ounces, Calories, and 'international units'; for convenience these terms are shortened to 'g.', 'oz.', 'Cal.', and 'i.u.', respectively.

A gram is a unit of weight; 28 grams equal roughly one ounce (the exact

## GENERAL INTRODUCTION

figure is : 28.35 g. = 1 oz.) and 1 gram = 1,000 milligrams (1,000 mg.). Consequently a food known to contain 14 g. of carbohydrate per oz. could equally well be said to contain 14 g. per 28 g., or 50 g. per 100 g., i.e. 50 per cent carbohydrate.

The energy value of food is measured in terms of heat units called Calories. The Calorie used in nutritional studies is known as the 'large calorie', which is the amount of heat needed to raise the temperature of 1,000 grams of water by one degree Centigrade—from 15° to 16°. The word Calorie in its nutritional use should be written with a capital C to distinguish it from the calorie used in the science of physics (which is the amount of heat needed to raise the temperature of one gram of water by one degree Centigrade, from 15° to 16°).

### *Energy value of nutrients.*

1 g. carbohydrate absorbed by and oxidised in the body produces	4 Cal.
1 g. fat	9 Cal.
1 g. protein	4 Cal.

*International Units* (i.u.) have been adopted for a number of vitamins as an agreed measurement of their value to the body.

## CHAPTER II

### CARBOHYDRATES

A carbohydrate is, as already stated, a nutrient which provides the body with energy, and in some circumstances may be converted into fat stored in the body.

There are three kinds of carbohydrate : (1) sugars ; (2) starch ; and (3) cellulose and related materials.

#### 1. SUGARS. The principal kinds are :

(i) *Glucose*, the simplest sugar, made from starch or by splitting a more complex sugar (such as cane sugar), and occurring naturally in the blood of living animals and in fruit and plant juices. It is specially abundant in onions, unripe potatoes and sweet corn.

(ii) *Fructose*, another simple sugar, which can in some circumstances be changed into glucose, and can also be derived from cane sugar of which it forms a part. It is the sweetest sugar and occurs naturally in plant juices, fruit, and especially in honey.

(iii) *Sucrose*, which is cane or beet sugar under its scientific name (cane and beet sugar being identical), and is the chemical combination of glucose and fructose. It also occurs naturally in sweet fruits and in roots such as carrots.

(iv) *Lactose*, similar to but less sweet than sucrose, and also a combination of two sugars (glucose and *galactose*). It occurs in human and all other milk.

(v) *Maltose*, formed naturally from starch during the germination of grain, and also occurring in the production of malt liquors such as beer. Its chemical composition is a combination of two glucose sugars.

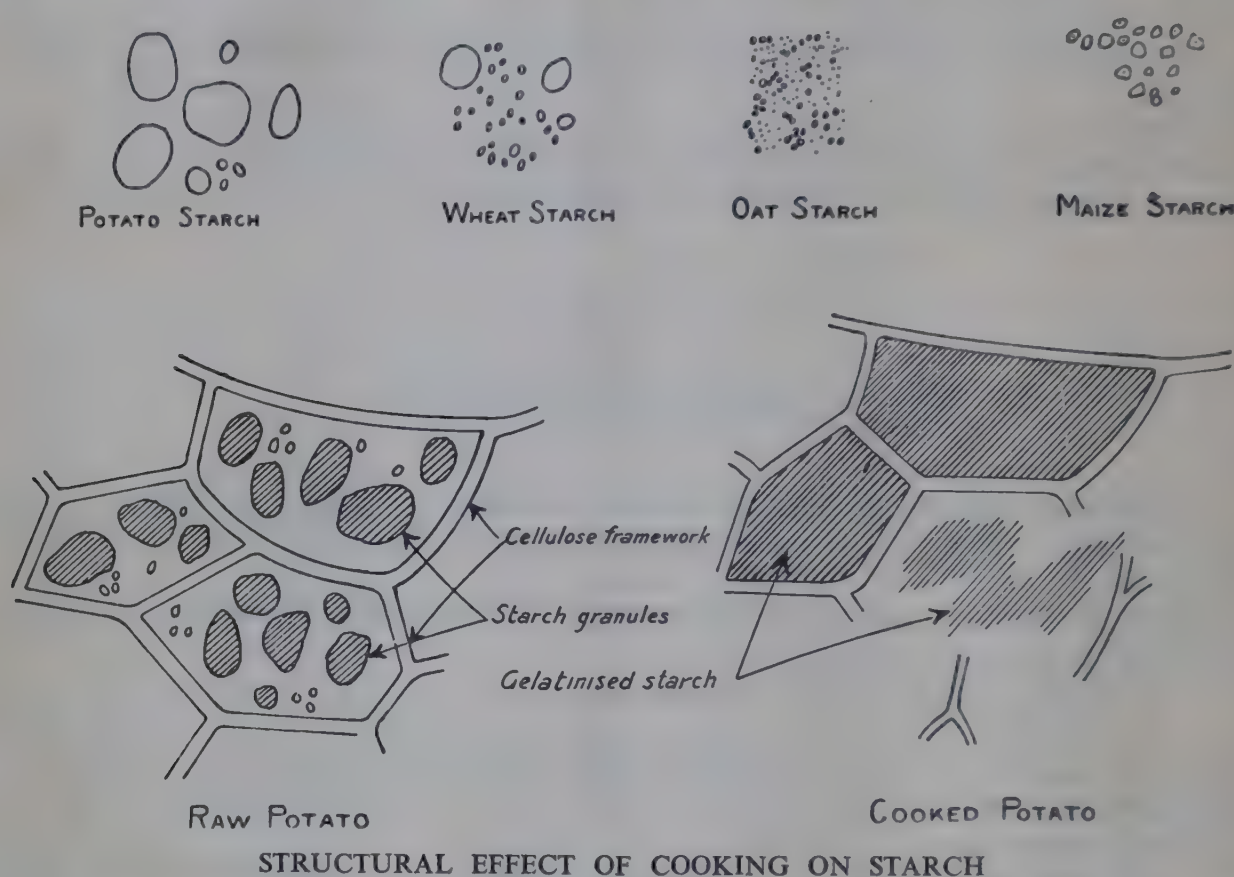
*Properties of Sugars.* Sugars, the simplest members of the carbohydrate group, are all sweet and all soluble in water, and are capable of forming crystals when the water in which they are dissolved becomes saturated with them.

*Nutrition and Sweetness.* Sweetness is pleasant to the taste but has no nutritional effect. Saccharin, which is also sweet, bears no chemical or nutritional relationship to sugar. It is of no value to the body, and therefore does not rank as a food.

## MANUAL OF NUTRITION

2. **STARCH.** By far the largest proportion of carbohydrate in human food occurs in starch. Starch is the form in which plants store the greater part of their food reserves ; consequently it comprises more than half the solid material in cereal grains and in potatoes. Unripe apples and bananas also contain starch which changes to sugar as the fruit ripens.

Starch consists of glucose units chemically combined. The actual starch in, say, potatoes or flour is enclosed within granules, which can easily be seen through a microscope and differ in appearance according to the substance which they compose. Starch granules cannot easily be digested ; therefore such materials as flour and potatoes cannot easily be digested until they have been heated in water. This process swells the granules until they burst and release the starch.



*Properties of Starch.* Plants form sugar by the action of the sun on their green leaves, but they store that sugar as starch in their stems, roots or seeds. The granules in which stored starch is contained prevent its being soluble in cold water, but if the granules are heated and broken a starch paste is formed. Starch never takes the form of crystals. When heated it may change to dextrin, which is more soluble than starch itself, but less soluble than sugar. Bread starch is changed to dextrin when the bread is toasted. Dextrin is used as gum on postage stamps.

*Glycogen.* similar to starch in composition, is made from glucose in the liver and muscles of living animals, and is the form in which the carbohydrate fuel of the body is increased ; after a spell of hard muscular effort the glycogen supply may be almost exhausted. The amount of glycogen in most meat is very small, as it breaks down into glucose after the death of the animal. An exception is horseflesh, which retains a higher proportion of glycogen ; if horseflesh is well chewed the glycogen then becomes glucose which gives the meat a sweet taste. Oysters and mussels also contain glycogen.

3. **CELLULOSE AND RELATED MATERIALS** compose much of the stiffer structure of vegetables and of cereal foods. In Fig. 1, which shows the structural effect of cooking potato starch, the uncooked starch granules are seen within their framework of cellulose. Cellulose is itself composed of a

## CARBOHYDRATES

combination of sugar molecules, but is even less soluble than starch, and so almost completely unavailable to the human body as direct food. It is of some value as giving bulk to the diet. Ruminating cattle can, however make direct use of cellulose as food ; certain insects, notably the death-watch beetle and the worms which invade old furniture, can obtain energy from it. Manufacturing processes have been devised for breaking down the cellulose in sawdust and other materials into the glucose of which it is composed.

*Hemi-cellulose.* Mild chemical treatment converts the cellulose in straw to hemi-cellulose which is partly available as food for cattle ; these animals have digestive machinery able to deal with it. Beans contain large amounts of hemi-cellulose.

*Pectin* is a complex carbohydrate present in apples and other fruit and in such roots as turnips. It has that property of forming stiff jelly which causes jam to set. Pectin, like hemi-cellulose, is of no direct nutritive value as food for man.

### FOODS WHICH CONTRIBUTE CARBOHYDRATES TO DIET

All carbohydrates absorbed by the body contribute heat or other energy or may be converted to fat. When foods are compared for their carbohydrate content, it is logical to consider the *total carbohydrates available to the body* rather than the different proportions of sugars, starch and indigestible cellulose. The list below compares foods according to their totals of carbohydrates available.

Almost all foods contain more than a single nutrient. Among the few exceptions is sugar as provided by the grocer, which is 100 per cent carbohydrate. Bread, which ranks highly as a source of carbohydrate, also contains substantial proportions of protein and other nutrients.

#### AVAILABLE CARBOHYDRATE CONTENT OF CERTAIN FOODS <sup>(1)</sup>

g. per oz.					g. per oz				
Sugar ... ..	...	...	...	28.4 <sup>(2)</sup>	Potatoes ... ..	...	...	...	4.6
White flour ... ..	...	...	...	20.5	Beans, baked ... ..	...	...	...	4.5
Syrup ... ..	...	...	...	20.2	Apples ... ..	...	...	...	3.0
National flour ... ..	...	...	...	19.9	Cherries ... ..	...	...	...	3.0
Oatmeal ... ..	...	...	...	18.6	Parsnips ... ..	...	...	...	2.9
Jam ... ..	...	...	...	17.6	Pineapple ... ..	...	...	...	2.9
Raisins ... ..	...	...	...	16.4	Pears ... ..	...	...	...	2.7
Dates ... ..	...	...	...	16.3	Peas, green ... ..	...	...	...	2.7
Currants ... ..	...	...	...	16.1	Beetroot ... ..	...	...	...	2.3
White bread ... ..	...	...	...	15.3	Oranges ... ..	...	...	...	2.2
Bananas, peeled ... ..	...	...	...	4.9					

(<sup>1</sup>) Expressed as starch.

(<sup>2</sup>) Expressed as sugar.

## CHAPTER III

### FATS

The substances here defined as fats include all fatty materials, such as meat fat, butter fat, and all oils derived from animal and vegetable sources.

1. Fuel for energy can be stored in plants as starch, and in plants, animals and animal foods as fat. Fat is the more compact form and therefore contains the higher concentration of fuel.

2. In plants, fats are formed from carbohydrate. When seeds such as cotton seed or linseed ripen, their starch content lessens as their fat content increases. Oil seeds such as these are among the chief sources of fat for manufacture of margarine.

3. In animals, as in plants, fat may be formed from carbohydrate. If

## MANUAL OF NUTRITION

more starchy food is eaten than is necessary for the energy to be expended, fat is laid down in the body. Pigs can be fattened on food largely composed of carbohydrate. Animals, however, can form fat not only from carbohydrate, but can also deposit in their bodies some of the fat from their food. If a pig is given large quantities of cod liver oil, its own body-fat will soon taste of the oil.

4. The food value of all common fats is roughly equal, although some natural fats contain other nutrients of additional value.

### CHEMICAL NATURE OF FATS

1. Fats are insoluble in water ; the property which most readily distinguishes them from other components of food is their solubility in such liquids as petrol, chloroform, or ether, which are accordingly sometimes described as fat-solvents. Fat-solvents themselves will usually not mix with water.

2. The physical qualities of fats differ chiefly because of the various temperatures at which they become liquid. Oils are fats which remain liquid at ordinary atmospheric temperatures ; if cooled, they become solid.

3. When fats are treated with alkali—for example, soda—they split into *glycerol* and *soap*. The splitting process is called *saponification*. Both glycerol and soap are soluble in water, so that fat can itself be dissolved in water by this means.

*Fats and oils useful to the body as food can all be saponified. Mineral oils such as liquid paraffin, or greases such as vaseline, cannot be saponified ; they are therefore not available for production of body energy, and so are not foods.*

4. Chemically fats consist of three *fatty acid* units combined with a single unit of *glycerol*. During saponification these fatty acids combine with the alkali to form *soaps* ; the glycerol remains free.

A large number of different fatty acids are known to exist. Fats themselves differ because of the various fatty acids they contain. For example :

- (a) The distinctive flavour of *butter* results chiefly from the presence of *butyric acid*, which has a strong unpleasant smell. When butter becomes rancid some of its butyric acid breaks off from the butter-fat and being volatile gives the rancid smell.
- (b) *Caprylic acid* is one of the fatty acids in coconut oil, in butter made from cow's or goat's milk, and in human fat ; it is one of the substances which give goats their characteristic smell (the word 'caprylic' is derived from the Latin *caper*, a goat).
- (c) *Palmitic* and *stearic acids* are present in almost all fats, and are the acids most frequently found in *solid fats*.
- (d) *Oleic acid* is also frequently present, most often in liquid oils.

Unbroken fat, in which the fatty acids are chemically combined with glycerol, is not soluble in water, but is soluble in fat solvents such as ether. When fat is split up by saponification the bulk of it—in the form of free glycerol and free fatty acids, or soaps or fatty acids—becomes water-soluble. In all natural fats, however, a small residue remains unsaponified. This unsaponifiable residue contains a mixture of substances, of which some may be of nutritional value. If a fat contains vitamins, they will remain in this unsaponifiable residue.

### FAT CONTENT OF CERTAIN FOODS

		g. per oz.	per cent
Frying oil, olive oil, cottonseed oil, etc. ...	...	28.4	100
Lard, dripping ...	...	28.1	99
Margarine ...	...	24.2	85
Butter ...	...	23.4	83
Brazil nuts ...	...	17.4	62

## FATS

### FAT CONTENT OF CERTAIN FOODS (*cont'd.*)

							g. per oz.	per cent
Almonds	...	...	...	...	...	...	15.2	54
Peanuts	...	...	...	...	...	...	13.9	49
Bacon	...	...	...	...	...	...	12.8	45
Coconuts	...	...	...	...	...	...	10.2	36
Cheese	...	...	...	...	...	...	9.8	35
Mutton	...	...	...	...	...	...	8.8	31
Beef ...	...	...	...	...	...	...	7.9	28
Herring	...	...	...	...	...	...	3.3	12
Egg ...	...	...	...	...	...	...	3.3	12
Salmon, canned	...	...	...	...	...	...	2.8	10
Milk ...	...	...	...	...	...	...	1.0	4

Oils and fats such as cooking oil and dripping are almost 100 per cent fat. Butter is a mixture of butter-fat (from milk) and water, and also contains a proportion of salt and certain other nutrients. The figures given above for the amount of fat in beef and mutton are averages. Meat may of course vary widely in fatness, according to the diet of the animal from which it came.

Fish such as herrings, mackerel, salmon, sardines, pilchards and eels are sometimes called *fat fish*. The proportion of fat in them depends, however, on their sexual development, and varies with the time of year. *White fish*, including cod, whiting, haddock and sole, contain very little fat.

Most vegetables and fruits contain very little fat; the exceptions are the majority of nuts, and soya products.

The fat content of flour and other cereal products is small, except that oatmeal contains 2.5 g. fat per oz.

## CHAPTER IV

## PROTEINS

Proteins are essential constituents of plant and animal cells. No known living matter is without them. Therefore a supply of protein is needed for growth and repair of the human body. The muscular tissue—that is, lean meat—in the bodies of animals is also composed of protein, and is a source of protein for the diet of human beings.

Plants can build up carbohydrate, and so obtain energy, from substances present in soil and air; they can also form their own protein from inorganic materials. Animals cannot form protein in this way, but they can use as food the protein from plants.

There are thus two sources of protein for human nutrition:

1. ANIMAL PROTEIN, which is a constituent of—

- (a) Meat of all kinds.
- (b) Game, poultry, etc.
- (c) Fish of all kinds, including shellfish.
- (d) Milk, including dried and condensed forms.
- (e) Cheese.
- (f) Eggs.

2. VEGETABLE PROTEIN. The proportion of protein in the plant cells of both green and root vegetables is small. In root vegetables it varies; potatoes contain more protein than turnips or carrots. Among seeds the proportion is highest in peas and beans; dried peas and beans contain most protein of all, but there the value is several times less when the dried vegetable is soaked. Nuts may be grouped with other seeds, having a protein content similar to that of peas and beans, but as nuts are eaten dry they retain their high content and therefore take the lead as a source of protein.

CEREALS form the most important class of seed foods. In a grain of cereal such as wheat the most active living cells are in the embryo from which, if

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the grain is planted, the new plant will develop. The larger proportion of the grain consists, however, of the stored starch upon which the plant depends for life until it has grown leaves. This starch makes the grain attractive as a food for man, although it contains less protein than the part of the grain associated with the embryo. While the whole grain contains useful amounts of protein, the proportion of protein is lessened according to the more complete removal of the parts associated with the embryo during the process of milling flour. Thus brown flour contains less protein than the wheat from which it is made, and white flour contains less protein than brown flour.

### PROTEIN CONTENT OF CERTAIN FOODS

<i>Animal foods</i>							g. per oz.	per cent
Cheese	...	...	...	...	...	...	7.1	25
Corned beef	...	...	...	...	...	...	7.1	25
Fish	...	...	...	...	...	...	4.5	16
Beef	...	...	...	...	...	...	4.4	15
Mutton	...	...	...	...	...	...	3.7	13
Egg	...	...	...	...	...	...	3.5	13
Milk	...	...	...	...	...	...	0.9	3
<i>Vegetable foods</i>								
Soya flour	...	...	...	...	...	...	11.5	40
Peanuts	...	...	...	...	...	...	8.0	28
Brown flour	...	...	...	...	...	...	3.4	12
White flour	...	...	...	...	...	...	3.1	11
Beans, baked	...	...	...	...	...	...	1.7	6
Peas, green	...	...	...	...	...	...	1.6	6
Spinach	...	...	...	...	...	...	0.8	3
Potato	...	...	...	...	...	...	0.6	2
Cabbage	...	...	...	...	...	...	0.4	2
Carrot, turnip	...	...	...	...	...	...	0.2	1

### USES OF PROTEIN IN THE BODY

These uses are, as already stated, mainly for two purposes : (1) growth and repair, and (2) production of heat or other forms of energy.

1. *For growth and repair.* The protein structure of the human body differs from that of plants, and although similar to that of animals is not identical with it.

If protein in the diet is from *vegetable sources*, a variety of foods must be eaten in quite large amounts, so that the body may have the opportunity to break down the proteins and so to find sufficient ingredients to be rebuilt as human muscle.

If protein in the diet is from *animal sources*, less will be needed, for as has been said above, the difference between animal and human protein is less than that between vegetable and human protein.

If protein in the diet is from *mixed vegetable and animal sources* the amount required may be as little as if it came from animal sources only, because the variety of protein available may enable the body to turn it economically into human protein.

Protein being needed for growth, growing children and pregnant or nursing women obviously need a greater proportion of protein in their food than do adults who need it for repair and maintenance only. A certain amount of protein is *necessary* for everybody.

2. *As a source of energy.* In normal circumstances the amount and kind of protein in food will not exactly balance requirements for growth and repair ; there is usually a proportion of protein material to spare. This spare amount is used for production of heat or other energy. *Protein is as useful as carbohydrate for the provision of bodily energy, but its fundamental importance in the diet is for growth and repair ; for purposes of growth and repair no other nutrient can replace it.*

# PROTEINS

## COMPOSITION OF PROTEIN

Whereas starch is composed of a number of glucose units of the same kind (so that, for example, purified rice starch, potato starch and corn starch are all very similar), proteins are composed of *numbers of amino acid units of different kinds in different arrangements* (so that, for example, beef protein, bean protein and cheese protein are by no means similar). A single protein may contain more than twenty different kinds of amino acid.

The human body can convert many amino acids of kinds it does not need into amino acids of kinds it does need. There are, however, eight amino acids necessary to the adult, and possibly ten necessary to the growing child, which cannot be made by the body and must therefore be supplied in diet. These are called the *essential amino acids*. Proteins in different foods can be graded according to their content of all ten essential amino acids in sufficient quantity to satisfy the needs of the body.

In general, animal proteins usually contain the essential amino acids in proportions suitable for human needs, while vegetable proteins may lack one or other of them. Therefore animal proteins are often called *first class proteins* and vegetable proteins *second class proteins*.

*It is an important principle that proteins derived from plants and proteins derived from animals may usefully be mixed in the diet.*

Where supplies of the more complete proteins are short, it is necessary to rely on a considerable proportion of the cereal proteins. There is no method of storing individual amino acids in the body. Either these acids are used together with other amino acids to make body proteins and other essentials, or they lose their nitrogen and are converted into carbohydrate or fat. It follows that for fullest use to be made of amino acids in diet, a complete assortment of those required should be supplied to the body altogether. If the proteins of flour, which are deficient in certain essential amino acids, are supplied at one time, and the proteins of meat, which contain plenty of the amino acids missing from flour, are supplied later, both the essential amino acids of the meat and the non-essential amino acids of the flour will be partly wasted for body-building purposes. Thus when the supply of meat, milk and cheese is scanty these foods should be (a) spread out over as many meals as possible and (b) eaten with bread, potatoes and cereal dishes such as porridge.

*Gelatin*, an animal protein derived from meat, is the principal ingredient in gristle, hoofs, horn, etc., and is completely deficient in at least one essential amino acid, *tryptophane*. Gelatin has, therefore, little food value unless it is supplemented by other proteins.

## PROPERTIES OF PROTEINS

1. *Some proteins dissolve in water.* An example is *egg albumen* (the white of egg), which coagulates when heated.

2. *Most proteins do not dissolve in water*, but many common food proteins dissolve in *salt and water mixtures* of various strengths.

3. Proteins subjected to intense heat, or treated drastically in other ways, become *denatured*, i.e. their essential qualities are changed. At the same time they usually harden to varying degrees.

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## CHAPTER V

### FOOD CONSUMPTION AND PHYSICAL WORK

It has been explained that one of the principal uses of food is to supply energy to the living body, and that each of the three nutrients (carbohydrate, fat and protein) of which the diet is composed can provide this energy. Most foods contain a mixture of these three nutrients ; the total energy value of such foods is therefore the sum of the energy derived from their carbohydrate, fat and protein.

#### ENERGY VALUE OF NUTRIENTS

It has also been stated (page 3) that 1 g. carbohydrate produces 4 Cal., 1 g. fat produces 9 Cal., and 1 g. protein produces 4 Cal. By using these values, the energy value of any food can be calculated from the proportion of nutrients in it.

For example, bread contains 14.9 g. carbohydrate, 0.3 g. fat, and 2.5 g. protein per oz. The energy value of 1 oz. bread can thus be calculated :

$$14.9 \times 4 = 59.6 \text{ Cal. from carbohydrate.}$$

$$0.3 \times 9 = 2.7 \text{ Cal. from fat.}$$

$$2.5 \times 4 = 10.0 \text{ Cal. from protein.}$$

$$\text{Total} \quad \underline{72.3 \text{ Cal.}}$$

#### ENERGY VALUE OF FOODS

As the Calorie value of foods is derived from the amount of nutrients in them, it follows that *very watery foods* (e.g. turnips, lettuce, soup) have little energy value. Foods rich in fat have the highest Calorie value, as here shown :

Cal. per oz.					Cal. per oz.				
Cooking fat	...	...	...	253	Potato	...	...	...	21
Butter	...	...	...	211	Banana	...	...	...	21
Bacon	...	...	...	128	Milk	...	...	...	17
Cheese	...	...	...	117	Apples	...	...	...	12
Sugar	...	...	...	108	Beer	...	...	...	10
Beef	...	...	...	88	Orange	...	...	...	10
White bread	...	...	...	72	Cabbage	...	...	...	7
Dates	...	...	...	68	Turnip	...	...	...	5

Energy value of meat depends largely on the amount of fat in it. Meat is mostly composed of the two nutrients protein and fat, plus water. Increase in the proportion of fat in meat is associated with decrease in the proportion of water, not of protein ; thus the extra fat represents a clear gain to the diet. Amounts of fat in two pieces of beef, for example, may of course vary widely ; this variance consequently affects the Calorie value. The composition of other foods may fluctuate similarly ; the figures given above must therefore be taken as averages and applied with judgment.

Figures for milk and beer in the above are given, as for other foods, in Calories per oz. There are 20 oz. in one pint. Thus a pint of milk provides 340 Cal. and a pint of beer 200 Cal.

#### USE OF ENERGY BY THE BODY

Energy from food is used by the body for three purposes :

- (1) To maintain the processes of living, e.g. heartbeat ; circulation of blood ; breathing ; maintenance of body temperature (the amount of energy needed for these processes is called the body's *metabolism*).

## FOOD CONSUMPTION AND PHYSICAL WORK

- (2) For everyday activities, e.g. standing ; eating ; moving about ; dressing.
- (3) For performance of muscular work (no energy from food is required for *mental* work).

The amount of energy used by different people for each of the above three purposes depends on the total amount of their living tissues and is found to be *proportional to the surface area of the individual body*. As men are in general bigger than women, the total number of Calories needed by average men is greater than the total number needed by average women. As children have a smaller body surface than adults their need for Calories in food is less ; on the other hand children have a larger surface in relation to their weight and are more active, so that although their total needs remain smaller, their needs in proportion to their size are greater than those of adults.

In addition to *size*, these three factors powerfully affect the energy requirement of the individual : (a) *degree of physical activity of daily life* ; (b) *age* ; and (c) *sex*.

1. ENERGY NEEDED TO MAINTAIN THE PROCESSES OF LIVING. In Great Britain the energy used by people of average size, if restricted to the mere processes of keeping alive, is about 70 Cal. per hour for men and 60 for women. The average needs per day are thus 1,700 Cal. for men and 1,450 for women.

2. ENERGY NEEDED FOR EVERYDAY ACTIVITY OF LIFE. The man's expenditure of 70 Cal. per hour merely keeps him alive ; he needs additional energy every time he moves. Amounts required for different kinds of additional energy are as follows, in Cal. per hour :

Sitting ... ..	15	Walking moderately fast ...	215
Standing ... ..	20	Walking downstairs ...	290
Dressing or undressing ...	33	Walking upstairs ...	1,000
Walking slowly ... ..	115		

Average figures for energy expended during 8 hours filled with miscellaneous domestic activities are : men, 360 Cal. ; women, 215 Cal. These figures are of course inappropriate for many individual cases where, for example, there are numerous stairs to be climbed or much walking is done.

3. ENERGY NEEDED FOR WORK. Everybody, regardless of occupation, needs food to maintain the processes of living and for the everyday activity of life ; but the decisive factor in the amount of food needed by an individual is the muscular activity of his work. The approximate average number of Calories used in a variety of occupations is shown below :

								Cal. per hour
(a) <i>Sedentary occupations</i>								
Writing	...	...	...	...	...	...	...	20
Typing	...	...	...	...	...	...	...	30
Tailoring	...	...	...	...	...	...	...	45
(b) <i>Moderately active occupations</i>								
Shoemaking	...	...	...	...	...	...	...	90
Carpentering	...	...	...	...	...	...	...	140
Light engineering	...	...	...	...	...	...	...	140
(c) <i>Active occupations</i>								
Heavy carpentering	...	...	...	...	...	...	...	180
Light blacksmithing	...	...	...	...	...	...	...	275
Stonemason's work	...	...	...	...	...	...	...	300
(d) <i>Very active occupations</i>								
Coal-mining	...	...	...	...	...	...	...	320
Heavy blacksmithing	...	...	...	...	...	...	...	350
Woodcutting	...	...	...	...	...	...	...	380

*Note.*—It is important to remember that all these figures are averages. Two important factors which may influence them are (a) that trained people can do work with less expenditure of energy than untrained people ; (b) that

## MANUAL OF NUTRITION

work of nominally the same character may vary widely in different circumstances.

### THE DAY'S NEED FOR ENERGY

The total daily Calorie needs of men doing work of varying degrees of activity can be calculated as follows :

(i) A clerk : sedentary occupation				Cal.
24 hours of the processes of living	...	...	...	1,700
8 hours of everyday activity	...	...	...	360
8 hours writing : $8 \times 20$	...	...	...	160
Total day's Calorie need				2,220
(ii) A carpenter : moderately active occupation				
24 hours of the processes of living	...	...	...	1,700
8 hours of everyday activity	...	...	...	360
8 hours of carpentering : $8 \times 140$	...	...	...	1,120
Total day's Calorie need				3,180
(iii) A blacksmith : active occupation				
24 hours of the processes of living	...	...	...	1,700
8 hours of everyday activity	...	...	...	360
8 hours of blacksmithing : $8 \times 275$	...	...	...	2,200
Total day's Calorie need				4,260
(iv) A woodcutter : very active occupation				
24 hours of the processes of living	...	...	...	1,700
8 hours of everyday activity	...	...	...	360
8 hours of woodcutting : $8 \times 380$	...	...	...	3,040
Total day's Calorie need				5,100

### FOOD CALORIES AND FATNESS

If more food is eaten than is needed for an individual's daily activity some of it will be converted in the body into fat. Just as Calories are supplied either by carbohydrate, fat or protein, so can any of these three nutrients be converted into body fat if they are eaten in excess of the Calorie output of work. Thus, the most 'fattening' foods are those which contain the most Calories. These are fats such as butter ; dishes including much fat, such as pastry or suet pudding ; sugar ; or commodities made with flour, particularly if these also include fat and sugar.

Individuals vary in their propensity to get fat, usually because they differ in the activity of their daily life, but in general if people wish to become thinner they can do so by two methods :

- (a) *Decrease Calorie value of food eaten without decreasing bodily activity.*
- (b) *Increase bodily activity without increasing Calorie value of food eaten.*

These two principles reversed apply equally to people who want to get fatter. In considering this matter it is important to remember the figures given in the course of this chapter. For example, if a man who is trying to reduce his weight goes for a brisk twenty-minute walk he expends 70 to 80 Cal. If at the end of his walk he is thirsty and drinks half-a-pint of beer, the beer puts back the Calories he has used up. He cannot, therefore, be surprised if his weight does not change.

## FOOD CONSUMPTION AND PHYSICAL WORK

### HOT FOODS AND CALORIFIC SIGNIFICANCE OF THEIR TEMPERATURE

Body temperature is maintained by a part of the calorific value of the food eaten. The Calories provided by food are not, however, necessarily used to produce heat. Other forms of energy are needed by the body.

The heat of hot food provides only a trifling addition to the day's Calories. This can be seen in the following example :

An average soup provides 10 Cal. per oz. A half-pint serving (10 oz.) therefore contributes 100 Cal. The heat provided by the hotness of the soup, with a temperature of, say, 60°C., to the body, the temperature of which is 37°C., can be calculated as follows :

- (1) 10 oz. = 280 g.
- (2) 1 Calorie = by definition the heat needed to raise 1,000 g. of water 1°C.
- (3) Hence, the heat needed to raise 280 g. of soup from 37° to 60°C., i.e. 23°, amounts to

$$\frac{23 \times 280}{1,000} = 6 \text{ Cal.}$$

It can be seen that the heat of the soup, 6 Cal., is a trifling contribution compared with 100 Cal. in the fuel value of the soup, or compared with 3,000 Cal. needed during the day by a moderately active man.

On the other hand some of the Calories in hot soup are already in the form of heat, and warm the body of a cold, exhausted individual in just the same way as would an equal amount of hot water in a hot-water bottle.

### MECHANICAL EFFICIENCY OF THE BODY

The amount of mechanical work which a man can do in riding a bicycle, carrying bricks up a ladder, or hammering on a nail can be measured and expressed in Calories. When the amount of work, expressed as Calories, is compared with the energy value of the food, also expressed as Calories, the mechanical efficiency of the body can be calculated.

*In the course of ordinary industrial work, the efficiency of the body is about 15 per cent.* That is to say, food containing 1,600 Cal. is used up when a man does 240 Cal. of physical work.

As the body can only convert about 15 per cent of the Calories derived from its food into mechanical work (the percentage varies slightly for different kinds of mechanical effort) the remainder is converted in the form of heat. This is the reason why physical exercise makes the body hot.

### MAINTENANCE OF BODY TEMPERATURE IN HOT AND COLD WEATHER

Part of the energy used in maintaining the processes of the body, that is to say used for metabolism, is expended in keeping up the temperature of the body. Although it might be supposed that in cold weather more energy would be needed for this purpose and that the energy requirements for metabolism would consequently be increased, in actual fact the protection afforded by clothing keeps the metabolic rate comparatively stable all the year round.

In cold weather, if the protection of clothing is insufficient, the body temperature is maintained partly by an increase in metabolism, but principally by *an increase in physical activity* which produces spare heat for warming the body. This increase may either be voluntary and take the form of stamping the feet or beating with the arms, or it may be involuntary and take the form of shivering which equally serves to produce warmth.

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## FACTORS AFFECTING THE AMOUNT OF ENERGY EXPENDED IN BASAL METABOLISM

*Basal metabolism* is the amount of energy needed to maintain the functions of the body when it is lying still and warm and without food.

1. *Body Surface.* The total amount of Calories needed by an individual for basal (as for other) metabolism is proportional to his body surface. The figures in the table below show that basal metabolic needs of people of different sizes may vary for average groups by the difference between 1,986 and 1,431 Cal. That is to say that even when living the same kind of life, there may be a difference of 555 Cal. in the requirement of food.

2. *Age.* The energy used per square metre is lower for infants up to 1 year than for children between 1 and 14 years. At puberty, in both boys and girls, there is an increase in the basal metabolic rate. From the age of 14 years there is a gradual decrease in the amount of energy required per square metre. As will be seen from the following table, the industrial worker between 35-39 years of age requires about 140 Cal. more than a man of the same size aged 66 years :

EFFECT OF A MAN'S SIZE AND AGE ON HIS DAY'S BASAL METABOLIC  
REQUIREMENT OF CALORIES

	Height cm.	Weight Kg.	Surface Area sq. m.	Basal Metabolism
School boy (18 years)...	180	71	1.88	1,986 Cal.
Average industrial worker (35-39 years) ...	169	61	1.69	1,573 ..
Pre-1914 army recruit (20-24 years) ...	163	52	1.55	1,525 ..
Retired worker (66 years) ...	169	61	1.69	1,431 ..

In the table above, height is given in centimetres (1 cm. = 0.4 inch) weight is given in kilograms (1 Kg. = 2.2 lb.) ; surface areas are given in square metres (1 sq. m. = 1.196 sq. yards).

3. *Sex.* Women have a lower basal metabolic rate than men owing to their different size and shape, and also because they have a higher proportion of body fat.

4. *Individual differences in energy requirement.* Some people expend more energy and require more Calories than others for performance of a similar day's activity. The principles described in this chapter apply only to averages, because some individuals get fat on a diet which leaves others thin. These differences usually result from the varying degrees of activity of certain endocrine glands.

5. *State of health.* Certain diseases increase or decrease energy requirements.

6. *Food.* Metabolism is raised after food has been eaten.

7. *Starvation.* During starvation or under-nutrition, the basal metabolic rate becomes very much reduced. This serves as an automatic reduction of the body's daily drain on the sources of energy, such as its own fat, which remains open to it. The maintenance of life depends on more nutritional factors than Calories alone. If Calories are considered alone for a moment, and if the maintenance needs (i.e. basal metabolism) of an adequately nourished man are 1,550 Cal., after a prolonged fast of three weeks or more these needs will be reduced to little more than 1,000 Cal. Hence, prolonged starvation (i.e. absence of food) can reduce the basal metabolism by as much as 30 per cent. In these circumstances, a man who needs, say, 2,550 to carry out a day's sedentary work in an office, can, if he must, just subsist on 2,000 Cal.

8. *Exercise.* Metabolism is raised after exercise has been performed.

9. *Sleep.* Metabolism falls slightly after sleep, but as exercise is taken during

## FOOD CONSUMPTION AND PHYSICAL WORK

the day, the fall resulting from sleep is counteracted by the rise following exercise. For practical purposes a standard figure can be used.

10. *Climate.* Metabolism is increased by about 10 per cent in cold climates. In recent experiments with the Canadian Army this has been shown to be due partly to the extra work caused by the weight of clothing worn, and partly to an increase in involuntary activity.

### QUESTIONS ON PART I

(Chapters I to V)

1. What is food ?
2. What is a nutrient ?
3. How many kinds of carbohydrates are there ; what purpose does carbohydrate serve in the body and which kinds of food contain it ?
4. Which is better, cane sugar or beet sugar ?
5. What connection is there in nutrition between glucose and starch ?
6. How many grams are there in a pound ?
7. Why do men need more food than women ?
8. What is the nutritional difference between fat and oil ?
9. What are the main sources of fat in the diet ?
10. What is the value to the body of fat in the diet ?
11. Why is protein of special importance in the diet ?
12. What is the difference between protein from animal and from vegetable foods ?
13. Which is the better source of protein, egg or cheese ; peanuts or cabbage ; white flour or wholemeal flour ; milk or meat ?

14. A cake sufficient for 30 portions is made according to the following recipe :

Flour	...	...	...	2 lb. 4 oz.	Margarine	...	...	1 lb. 5 oz.
Sugar	...	...	...	1 lb. 5 oz.	Dried fruit	...	...	1 lb. 14 oz.
Eggs	...	...	...	9 (18 oz.)	Milk	...	...	3 oz.
Baking powder	...	...	...	$\frac{3}{4}$ oz.				

Calculate from the figures below how many Calories a person would get in one portion of the cake :

						Cal. per oz.
Flour	...	...	...	...	...	97
Fat	...	...	...	...	...	218
Sugar	...	...	...	...	...	108
Dried fruit	...	...	...	...	...	67
Eggs	...	...	...	...	...	45
Milk	...	...	...	...	...	17

15. Calculate from the figures below which contains more Calories, an ounce of sausage or an ounce of corned beef :

		Carbohydrate	Protein	Fat	(figures in g. per oz.)
Corned beef	...	0	7.1	4.5	
Sausage	...	3.9	3.0	3.9	

16. What happens to starch when potatoes are boiled ? When toast is made ?
17. What happens to people who eat more Calories than they need ?
18. For what purpose does an individual use Calories in the course of a normal day ?
19. Which requires more Calories : walking or running ? walking upstairs or downstairs ? sitting thinking or just sitting ?
20. Which of the following are foods and which are not ? Why ? Bread, tea, tobacco, beer, butter, liquid paraffin, rust.
21. What is the difference between malnutrition and starvation ?
22. What is the nutritive value of sweetness ?
23. What is the chemical nature of fat and how do fats differ from one another ?
24. What is an amino acid ? Can amino acids be made by the body ?
25. What is the nutritional value of gelatin ?
26. Why is a hard boiled egg hard ?
27. Why does exercise make you hot ?
28. What carbohydrate occurs in sawdust ? Is it of nutritional value ?
29. What is pectin ?
30. Which of the following contain protein : Hair, teeth, wool, sawdust, the gum on postage stamps, glue ?

## PART II

### CHAPTER VI : INORGANIC ELEMENTS (1)

The body contains 19 major inorganic mineral substances all of which must be derived from food. These substances are used for three main purposes :

- (1) *As constituents of bones* (i.e. the rigid structures which support the muscular system of the body) *and teeth*. Some of these minerals are : calcium, phosphorus, magnesium.
- (2) *As constituents of body cells*, of which muscle, blood corpuscles, liver, etc., are composed. Minerals having this function include iron, phosphorus, sulphur.
- (3) *As soluble salts* which give to the body fluids their composition and stability which are both essential for life. Among elements which serve this purpose are : sodium, potassium, chlorine.

In addition to the substances mentioned above, a number of other minerals which must be provided by foods have special purposes in the body. Iodine is a constituent of a substance in the thyroid gland which plays a part in controlling the rate at which energy is used in maintaining the body processes ; copper is needed, together with iron, for the formation of blood cells ; manganese plays a part in the gradual release of energy from foodstuffs ; cobalt has been found in the anti-pernicious-anaemia factor present in liver.

Many of these minerals are needed only in small amounts and are widely distributed in many foods. Although knowledge of their functions in the body is necessary for an understanding of nutrition, the importance of considering them in practical dietetics is small. Two minerals, calcium and iron, may, however, easily be lacking and will be discussed in Chapters VII and VIII.

#### SODIUM

Common salt (sodium chloride) is a compound of sodium and chlorine. All body fluids contain about 0.9 per cent of salt and it is essential for life that this amount should be accurately maintained. Muscular cramps are caused if there is a shortage of salt.

Salt is lost from the body in two ways : (a) in the urine, and (b) in the sweat. The amount of salt passed out in urine is regulated by the kidneys, but there is no means of control over the amount of salt lost in sweat. Extra salt must, therefore, be taken in food (1) in hot climates ; (2) when work is done at high temperatures, e.g. by miners in deep pits, stokers, steel workers ; or (3) after strenuous exercise.

The daily amount of salt needed by an adult is about 4 g. The whole of this may, however, be lost in sweat during 3 hours' exercise in the sun. People usually eat about 15 g. daily in their food. The amount not needed is harmlessly passed out in the urine.

Besides the salt added to meals in cooking or at the table, salt is present in most foods. Some examples are listed below :

#### *Sodium Content of Certain Foods*

mg. per oz.					mg. per oz.				
Bacon	...	...	...	348	Egg	...	...	...	38
Cornflakes	...	...	...	298	Herring, raw	...	...	...	37
Kippers, baked	...	...	...	281	Cod, steamed	...	...	...	28
Cheese, Cheddar type	...	...	...	174	Mutton chop, raw	...	...	...	26
Bread, National	...	...	...	112	Beef steak, raw	...	...	...	20
Butter	...	...	...	63	Milk	...	...	...	14

## INORGANIC ELEMENTS (1)

### POTASSIUM

Potassium behaves chemically in a similar manner to sodium. In the body, however, sodium chloride (salt) is present in the free fluids, but potassium chloride becomes incorporated in the cells of the muscles and the red blood cells of the blood. There is a loss of potassium in urine at the rate of about 3 g. a day. Potassium, unlike sodium, is not lost in sweat. Most common foods contain potassium, so that there is little likelihood of any deficiency in normal diets.

Although potassium deficiency is never likely to occur in normal European diets, this mineral cannot entirely be forgotten when considering the foods of African races and others whose diets may include substantial amounts of tapioca or sago, which, together with fats, purified starches such as arrowroot, and tripe, are low in potassium. Figures are shown below :

#### *Potassium Content of Certain Foods*

mg. per oz.				mg. per oz.			
Kippers, baked	...	...	148	Bacon	...	...	71
Cod, steamed	...	...	102	Milk	...	...	46
Mutton chop, raw	...	...	100	Egg	...	...	39
Beef steak, raw	...	...	95	Cheese, Cheddar type	...	...	33
Herring, raw	...	...	90	Cornflakes	...	...	32

### SOME OTHER MINERALS

MAGNESIUM forms part of the composition of bones and teeth. It is present in practically every type of food, and there seems no chance of its deficiency in any diet.

SULPHUR is obtained in the diet in combination with other nutrients. In particular, certain proteins are of nutritional importance because of the sulphur in them. If an appropriate choice of proteins is made the amount of sulphur needed by the body will almost certainly be obtained.

IODINE. Only very small quantities of iodine are needed by the body, although these amounts are essential to it. Iodine is derived in the diet from the following sources :

- (1) Drinking water and water used in cooking.
- (2) Sea fish, oysters, mussels, etc.
- (3) Certain vegetables, notably watercress and onions, grown on soils naturally containing traces of iodine.

In certain parts of England, particularly in Cumberland, Yorkshire, Derbyshire, Gloucestershire, Devonshire, Dorset and Somerset, in some parts of America, in Switzerland and elsewhere, the soils (and hence the drinking water and the native vegetables) are deficient in iodine and there is, in consequence, a deficiency in the diet. The signs of this shortage are cases of goitre among the population. Where goitre appears it is wise dietetic practice to use iodised salt, containing not less than 15 and not more than 30 parts of iodine per million parts of salt.

FLUORINE is found in bones and teeth. Its distribution in food is not very well known, but it is present to varying degrees in drinking water in different districts of Great Britain. The consumption of a small amount of fluorine is thought by some authorities to improve the hardness of the teeth ; recent work indicates that small amounts of fluorine in the drinking water decrease the amount of dental disease in children. Excessive amounts, however, cause chalky white particles known as ' mottling ' to occur on teeth. In England, Maldon (Essex) is most remarkable for the high proportion of fluorine in the drinking water ; mottling of teeth among the population is very noticeable there.

COPPER is present in very small amounts in almost all foods. Traces of it are necessary in the diet to enable iron (see Chapter VIII) to maintain the

## MANUAL OF NUTRITION

appropriate number of blood corpuscles and thus prevent anaemia. A source of copper other than the diet is copper cooking vessels, and provided that only traces of metal are supplied in this way, no harm results.

### CHAPTER VII

## INORGANIC ELEMENTS (2)

Bones and teeth consist mainly of calcium phosphate, which is itself largely composed of calcium and phosphorus. It is therefore important that the diet should contain *enough* calcium and phosphorus, and a *satisfactory proportion* of calcium to phosphorus.

### CALCIUM

Calcium has several functions in the body, being necessary for : (a) proper development and growth of bones and teeth ; (b) normal clotting of blood ; and (c) normal functioning of muscles.

*The need for calcium in different groups is as follows :*

1. *In children.* Children, who are growing and forming new bones and teeth, need more calcium than adults. If their diet does not provide enough the results are : (i) rickets, (ii) reduced growth, and (iii) badly formed teeth.

2. *Expectant and nursing mothers* require more calcium than other people, the expectant mother in order to form the bones of the child, the nursing mother to produce calcium in her own milk. If insufficient calcium is available in the mother's food she will draw on that stored in her own bones ; even in spite of this, her child may either be born with rickets or readily contract the disease.

3. *In other adults.* Insufficient calcium in the food of adults may lead to bad teeth, but a reduction in the level of calcium in the blood will probably not occur, as the body has power to withdraw calcium from its bones in order to maintain this level.

4. *In old people.* A constant drain on the calcium in the bones, to compensate for a shortage in the diet, may be partly the cause of the steady demineralisation which takes place in old age and which leads to brittleness of the bones. Many of the so-called 'rheumatic' pains suffered by old people may be due to a continued shortage of calcium affecting the joints.

*Calcium in the blood and muscles.* A small constant proportion is always present in the blood, being necessary (a) as part of the mechanism of clotting : (b) for the proper functioning of the muscles.

In order that the amount of calcium in blood shall remain constant, the bones act as a reservoir from which calcium can quickly be obtained, and in which excess calcium can be deposited. The parathyroid gland, a small organ attached to the thyroid gland in the neck, controls the level of calcium in the blood. Should the parathyroid become diseased or damaged, the amount of calcium in the blood may fall. A condition of tetany (muscular spasm) will then occur, and may quickly prove fatal.

#### *Calcium Content of Certain Foods*

mg. per oz.				mg. per oz.			
Dried skim milk	...	...	347	Cabbage	...	...	18
Cheese	...	...	230	Turnip	...	...	17
Sardines	...	...	113	Egg	...	...	17
Condensed milk, whole	...	...	82	Cauliflower	...	...	14
Watercress	...	...	63	Cod	...	...	7
Liquid milk	...	...	34	White flour	...	...	5
National bread	...	...	30	Meat, most types	...	...	3
Herring	...	...	28	Potato	...	...	2

## INORGANIC ELEMENTS (2)

Diets can become deficient in both calcium and phosphorus. In England, although a shortage of calcium was one of the commonest nutritional faults before the war, shortage of phosphorus is very unlikely.

Unless the diet includes enough of those few foods which contain substantial amounts of calcium it will almost certainly provide too little for health. These foods are : *Cheese, milk and milk products ; fish of which the bones are eaten (e.g. sardines, tinned salmon) ; National bread ; green vegetables.* A source of calcium other than food is provided by *water used for drinking or cooking*, provided that it is 'hard' water.

Two outside factors affect the precise amount of calcium needed to protect an individual from the different effects of shortage already listed : (i) the amount of phosphorus present in the food together with the calcium (see below) ; and (ii) the amount of vitamin D in the diet. (See Chapter X.)

### PHOSPHORUS

Phosphorus is used by the body for a number of vital purposes, which may be divided into these three main groups :

1. Phosphorus, with calcium, is a major constituent of bones and teeth.
2. Phosphorus plays an essential part in the complex processes by which the body obtains the release of energy from the nutrients of food.
3. Phosphorus is essential for maintaining that constancy in composition of body fluids necessary for the continuance of life.

Besides these main uses, phosphorus is concerned in the life and structure of all the cells in the body.

#### *Phosphorus Content of Certain Foods*

				mg. per oz.					mg. per oz.
Cheese	...	...	...	155	Egg	...	...	...	62
Oatmeal	...	...	...	108	National bread	...	...	...	28
Liver	...	...	...	89	Milk	...	...	...	27
Kidney	...	...	...	74	Fruit	...	...	...	5

Except milk and milk products such as cheese, all common foods contain substantially more phosphorus than calcium. Phosphorus deficiency is therefore very improbable in any normal diet. This suggests that the consumption of additional phosphorus in medicine is usually unnecessary. Again, although phosphorus is concerned with the functioning of brain cells as of other cells, phosphorus eaten as food will have no direct influence on the brain itself. Brain contains 100 mg. of phosphorus per oz. which is more than the amount usually present in fish. The suggestion that fish is a 'brain food' is therefore unjustified.

### ABSORPTION OF CALCIUM

The actual amount of calcium that the body will absorb from the diet depends on several factors, chief of which are the following :

1. *Ratio of calcium to phosphorus in the diet.* Adults require about 1 part of calcium to 1.5 parts of phosphorus ; children and expectant and nursing mothers who have a greater need for calcium require at least as much calcium as phosphorus. If too much or too little phosphorus is available in proportion to calcium, further supplies of either substances are withdrawn automatically from the bones. If, however, the ratio of phosphorus to calcium in the diet becomes as large as 6 : 1 rickets may develop. A good supply of vitamin D in the diet can very often compensate for a wrong ratio.

2. *Amount of phytic acid or oxalic acid in food.* Phytic acid is a substance that occurs mainly in the bran and outer layers of cereals. Oxalic acid is a substance which occurs in small quantities in some green leafy vegetables, but in large quantities in rhubarb and spinach only. Both phytic acid and

## MANUAL OF NUTRITION

oxalic acid when linked with calcium form insoluble salts which are not absorbed by the body.

Very little calcium is lost to the body in these ways, because (a) much of the phytic acid present in bread which is made with yeast is broken down during baking, and (b) neither rhubarb nor spinach is eaten in very large quantities.

3. *Very large amounts of fat in the intestine*, which occur in some diseases, may prevent the body from obtaining calcium from food.

### *Calcium Content of British Diet*

It was known before 1939 that British diet was seriously deficient in calcium. It was feared that the changes in composition of national diet necessitated by the war, particularly the increases in vegetable consumption and in the extraction rate of flour (see p. 40) might reduce the amount of calcium absorbed from the food. It was decided to guard against the danger of calcium deficiency by adding calcium carbonate to national flour. In spite of the increased milk consumption and the recent lowering of the extraction rate of flour, the national calcium supply would not, even in 1952, reach requirements without this addition, which has therefore been continued. At the present time the addition is at the rate of 14 oz. of calcium carbonate per 280-lb. sack of flour.

## CHAPTER VIII

### INORGANIC ELEMENTS (3)

The substance which gives blood its red colour is built up on a basis of the metal iron, which must in the first place be derived from food. About three-quarters of the iron in the body is found in the blood ; it is necessary for the transport of oxygen round the body, and a sufficiency of iron in the diet is therefore essential for health.

Once iron is absorbed by the body, it is lost only very slowly. The red part of blood, which contains the iron, is composed of a number of cells called red blood corpuscles. The life of each corpuscle is about 6 weeks. At the end of that time the corpuscle breaks up and the iron is released ; it does not escape from the body, but is used again for the formation of fresh corpuscles. These new blood cells are produced in the marrow of the bones. In spite of the fact that iron is used over and over again, its replacement from food is necessary because it may be lost from the body in two ways : (1) by the general wear and tear of the body and in the remains of the digestive juices passed out in faeces, and (2) when bleeding occurs.

If food provides insufficient iron to replace the body's losses, *anaemia* will eventually occur ; but it must be emphasised : (1) that anaemia may be due to many other causes as well as to iron deficiency, and (2) that if an emia is to be quickly cured, very much larger amounts of iron must be consumed than can be conveniently supplied in food. These large amounts are best given as inorganic iron in medicine.

### *Iron Content of Certain Foods*

mg. per oz.				mg. per oz			
Liver, kidney	...	...	3.9	Raisins	...	...	0.5
Corned beef	...	...	3.1	Watercress	...	...	0.5
Beef	...	...	1.1	Fish	...	...	0.3
Egg	...	...	0.9	Cabbage	...	...	0.3
Baked beans	...	...	0.7	White bread	...	...	0.3
Wholemeal bread	...	...	0.6	Potato	...	...	0.2
Mutton	...	...	0.6	Milk	...	...	trace

## INORGANIC ELEMENTS (3)

Although most of the iron taken into the body is derived from *foods* listed in the above table, there are, besides food, two other useful sources of iron : (1) nutritionally valuable amounts may be present in the *water* used for drinking and cooking, and (2) iron can also be obtained from *kitchen knives and iron utensils*. Curry powder contains large amounts of iron, mostly derived from the iron vessels in which it is made. A fourth source of iron, other than food, water and utensils, is used today more by animals, particularly pigs, than by men. *Earth* contains substantial proportions of iron. If weanling pigs are kept in clean concrete styes where they cannot get earth to eat they develop anaemia. Although in England earth is not eaten purposely by human beings, this practice is followed by some African races.

*Availability of iron in different foods* varies, and iron is absorbed only when the body needs it.

### *Iron and Copper*

A very small amount of *copper* is needed together with iron in order that the iron may fulfil its functions in the body. Copper may be ignored in problems of practical nutrition, as sufficient will almost certainly be present in the diet. Iron itself, on the other hand, may easily be insufficient.

## CHAPTER IX

### VITAMINS : VITAMIN A

Until the beginning of the twentieth century it was assumed that diet would be adequate if sufficient protein, fat, carbohydrate and inorganic elements were supplied. This view was revolutionised when it was shown that natural unrefined foods contain substances essential for life and health which the body is unable to form for itself. These organic substances were called *vitamins* and were found to be present in very minute amounts in foods. Some of the vitamins, i.e. A, D, E, K, are found mainly in fatty food and are called fat-soluble vitamins ; the others, i.e. the vitamins of the B complex and vitamin C, are water-soluble vitamins.

VITAMIN A occurs in certain fats and in the fatty part of some foods. In the body, vitamin A (1) is necessary for the growth of children, (2) plays a part in the way the eyes perceive light, and (3) protects the skin, particularly moist areas, such as the front of the eyes, and the lining of the respiratory tract, throat and bronchial tubes. Failing a definite amount of vitamin A, bodily health will suffer, but if more vitamin A is consumed than is needed there will be no added benefit to health.

Vitamin A activity is provided : (1) by animal foods such as liver, dairy produce and eggs, and (2) by green vegetables and carrots.

The amount of vitamin A in foods is measured in *international units*.

#### *Vitamin A Content of Certain Foods*

								i.u. per oz.
1. <i>Animal foodstuffs</i>								
Halibut liver oil, B.P.	...	...	...	...	...	...	...	850,000
Cod liver oil, Ministry of Food	...	...	...	...	...	...	...	28,400
Ox liver	...	...	...	...	...	...	...	4,253
Butter	...	...	...	...	...	...	...	1,134
Margarine	...	...	...	...	...	...	...	500
Cheese, Cheddar type	...	...	...	...	...	...	...	369
Egg	...	...	...	...	...	...	...	284

(1) While this edition is going to press the Committee for the Reform of Biochemical Nomenclature of the International Union of Pure and Applied Chemistry has reached agreement on the nomenclature of some vitamins (see *Biochem. J.* 1952, 52, 1).

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Kidney ...	...	...	...	...	...	...	...	284
Sardine	...	...	...	...	...	...	...	77
Herring ...	...	...	...	...	...	...	...	43
Most meats	...	...	...	...	...	...	...	14

### 2. Vegetable foodstuffs

Carrot ...	...	...	...	...	...	...	...	5,198c*
Spinach ...	...	...	...	...	...	...	...	3,686c
Watercress	...	...	...	...	...	...	...	1,418c
Dried apricots	...	...	...	...	...	...	...	1,418c
Tomato ...	...	...	...	...	...	...	...	851c
Dried prunes	...	...	...	...	...	...	...	709c
Cabbage	...	...	...	...	...	...	...	255c
Green peas	...	...	...	...	...	...	...	142c
Potato, onion	...	...	...	...	...	...	...	0

\*The letter c after the value indicates that the sole source of vitamin A potency is the orange pigment *carotene*.

*Fish liver oils* are by far the most concentrated natural sources of vitamin A. They are used to fortify with vitamin A such foods as *margarine*, which do not naturally contain any. In 1940, margarine in Britain was fortified in this way with 450 to 550 international units of vitamin A per ounce.

The dairy products *milk*, *butter*, *cheese* and *eggs* may vary in the amount of vitamin A they contain, which depends on the amount in the food of the cow or hen. The concentration is usually highest in the summer when green grass is available.

In *green vegetables* the amount of vitamin A is proportional to their greenness. Dark green plants, such as watercress, contain greater concentrations of vitamin A than paler vegetables, such as cabbage. In cabbage, there is more vitamin A in the dark outer leaves than in the pale inner heart. In *carrots* the amount of vitamin is proportional to their yellowness.

The body can store vitamin A in the liver, so that a large amount of vitamin eaten in the autumn may suffice to maintain the body adequately for some time during the winter. This method of supplying vitamin A is, however, wasteful; more must be taken as one dose than would be needed as a steady daily amount. The high vitamin A value of liver as a food results from the use of this organ for storage by the animal from which the liver was taken.

### *Availability of Vitamin A in different Foods*

The amount of vitamin A in foodstuffs is measured by comparative tests on animals. A group of animals is fed on a basic diet to which is added a known quantity of the food to be tested. Their nutritional state is then compared with that of another group fed on the same basic diet with the addition of a known amount of vitamin A (international standard). Precise measurement of amounts of vitamin A is possible by this method, but *availability* of the vitamin to man varies for different materials, e.g. :

(1) Vitamin A from *animal foods* is more effective in the human body than that derived from vegetable foods.

(2) Vitamin A from carrots, which possess a tight fibrous structure, is less readily available to the body than vitamin A from green vegetables.

The assessment of the total amount of vitamin A needed daily by different individuals is usually an average figure assuming the consumption of a mixed diet. If the vitamin is entirely derived from animal sources, less will be needed.

### *The difference between Animal and Vegetable Vitamin A*

Chemically, vitamin A in cod liver oil and other animal foods differs from the substances which give vegetables their vitamin-A-activity. The vitamin A in cod liver oil is chemical vitamin A itself, often called *pre-formed vitamin A*. The main substance which gives vegetables their vitamin activity is the orange

## VITAMIN A

pigment *carotene* referred to in the table of Vitamin A Content of Foods. In dairy produce most of the vitamin A is pre-formed vitamin but part is carotene.

When carotene is absorbed into the body it may be converted into vitamin A. Rats, which are used for measuring the number of international units of vitamin A in foodstuffs, can change carotene into vitamin A very efficiently. Men are apparently not so efficient as animals in this respect ; hence animal sources of vitamin A are more effective in the diet than vegetable sources.

## CHAPTER X

### VITAMINS D, E, K

VITAMIN D is a substance concerned in the laying down of calcium and phosphorus in bones, and is therefore of special importance (1) to infants and children whose bones are in the process of growth and development, and (2) to expectant mothers in whom the bones of a foetus are developing.

When insufficient vitamin D is present in the diet of infants and children, the disease of rickets occurs. As, however, the formation of bone depends on (a) the total amount of calcium absorbed from the diet, (b) the total amount of phosphorus absorbed from the diet, and (c) the proportion of calcium to phosphorus, it is not easy to assess the precise amount of vitamin D necessary to ensure that the calcium and phosphorus are properly converted into bone.

#### SOURCES OF VITAMIN D

The body obtains vitamin D from two distinct sources : (1) *food*, and (2) *sunlight*. Foods which supply vitamin D are, with very few exceptions, animal products. The amounts present in some common foods are shown below :

##### *Vitamin D Content of Certain Foods*

	i.u. per oz.				i.u. per oz.
Cod liver oil, Ministry of Food...	5,670	Egg	...	...	17
Sardine ... ..	280	Butter	...	...	17
Herring ... ..	241	Cheese	...	...	4
Tinned salmon ... ..	170	Milk	...	...	0.3
Margarine ... ..	90				

There is a seasonal variation in the vitamin D content of milk, butter and cheese. Summer dairy produce contains more vitamin D than winter dairy produce. Herrings contain more vitamin D during the breeding season.

Sunlight acting on the skin can cause the formation of vitamin D in the body itself. Thus if children receive sufficient sunlight on their bodies the amount of vitamin D they will need from their food will be very much reduced.

Sunlight or another source of ultra-violet light, acting on certain foods which do not contain vitamin D, can cause the formation of the vitamin in these foods just as it does in the skin of the body. Cacao-shells, which are a by-product of the manufacture of chocolate, contain quite large amounts of vitamin D formed by the sun during the fermentation of cocoa-beans as part of the process of chocolate manufacture.

#### *Needs of adults for vitamin D*

Although infants, children and expectant mothers have by far the greatest need of vitamin D, other adults probably require a small amount. When supplies of calcium and phosphorus in a diet are insufficient and, in addition, the diet does not contain vitamin D, adults may develop osteomalacia, a disease of the bones bearing some similarity to rickets.

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### *Nature of vitamin D*

Vitamin D is not soluble in water. Like vitamin A, it occurs only in fats and the fatty parts of foods. Vitamin D is comparatively resistant to heat and to the conditions likely to occur in cooking and handling food.

### *Irradiated ergosterol*

The substance in foods which becomes converted into vitamin D upon exposure to ultra-violet light is *ergosterol*. If ergosterol is irradiated under controlled conditions a pure crystalline vitamin can be obtained. This material is *vitamin D<sub>2</sub>* (also called *calciferol*).

In order to distinguish vitamin D<sub>2</sub> from the vitamin found in cod liver oil, milk, etc., the latter is called vitamin D<sub>3</sub>. It can be made artificially by exposing a substance known as *dehydrocholesterol* to ultra-violet light.

### *Comparison between vitamin D<sub>2</sub> and vitamin D<sub>3</sub>*

1. Vitamin D<sub>2</sub> (irradiated ergosterol, calciferol) has for certain species of animals an activity equal to vitamin D<sub>3</sub>. Thus, it is completely effective in preventing and curing rickets in both rat and man, but is less potent for prevention of rickets in poultry, which often suffer from the disease when badly fed.

2. Vitamin D<sub>3</sub> (found naturally in cod liver oil, dairy produce, etc.) has an equal effect on bone formation in all the animals, including man, for which vitamin D<sub>2</sub> can be used. Poultry and other birds particularly subject to rickets are protected by vitamin D<sub>3</sub>. For these species very much larger amounts of vitamin D<sub>2</sub> have to be given in order to achieve the same result.

3. Both vitamin D<sub>2</sub> and vitamin D<sub>3</sub> can be manufactured. For technical reasons vitamin D<sub>2</sub> is usually employed for the fortification of margarine or for pharmaceutical preparations.

VITAMIN E was first identified as a substance necessary for the normal fertility of rats. There is no conclusive evidence that vitamin E plays any part in influencing fertility in human beings. It is found in milk and wheat-germ and in the small amount of fat present in green vegetables.

VITAMIN K is essential for normal clotting of blood. It is found naturally in green plants such as cabbage and green peas. Deficiency of this vitamin is unlikely in a person eating a well-balanced diet.

## CHAPTER XI

### THE VITAMIN B GROUP OF NUTRIENTS

The term vitamin B comprises a number of substances often, but not always, found together in the same foods. The individual members of the group to be considered here include the following :

- (1) Vitamin B<sub>1</sub>, also called aneurin in England and thiamin in America.
- (2) Riboflavin, sometimes called vitamin B<sub>2</sub> or vitamin G, but these names are now little used.
- (3) Nicotinic Acid, now called niacin in America.

Besides these three substances, at least eight others are known :

- |                      |                             |                            |
|----------------------|-----------------------------|----------------------------|
| (4) Pyridoxin        | (7) Folic Acid              | (10) Paramino-benzoic Acid |
| (5) Pantothenic Acid | (8) Vitamin B <sub>12</sub> | (11) Inositol              |
| (6) Biotin           | (9) Choline                 |                            |

## THE VITAMIN B GROUP OF NUTRIENTS

### VITAMIN B<sub>1</sub>

1. Vitamin B<sub>1</sub> is composed of carbon, hydrogen, oxygen, nitrogen and sulphur ; in the body it is effective in association with phosphoric acid. Like all other members of the vitamin B group of nutrients it is soluble in water.

2. The function of vitamin B<sub>1</sub> in the body is to form part of the subtle machinery by means of which a steady and continuous release of energy is obtained from carbohydrate.

3. The signs of ill health which develop if insufficient vitamin B<sub>1</sub> is provided by the diet are : (i) a check in the growth of children ; (ii) development of a special type of neuritis ; (iii) the subject becomes depressed, irritable and quarrelsome ; (iv) extreme deficiency results in the disease beri-beri, seldom seen in Europe, but common in the Far East where many people live largely on white rice from which most of the vitamin B<sub>1</sub> has been removed during its preparation.

4. The amount of vitamin B<sub>1</sub> needed in the diet is proportional to the number of Calories provided by any nutrient other than fat. In order to make use of 100 Cal. from carbohydrate or protein, the body requires 0·06 mg. of vitamin B<sub>1</sub>. To decide, therefore, whether any particular food is or is not a real source of vitamin B<sub>1</sub> in the diet it is necessary to calculate whether it provides more than 0·06 mg. for each 100 Cal.

For example :

1. *Wholemeal bread* : 1 oz. provides 70 Cal., little of which is derived from fat, and contains 0·07 mg. vitamin B<sub>1</sub>.

Hence sufficient wholemeal bread to provide 100 Cal. also provides 0·10 mg. of vitamin B<sub>1</sub>. This is in excess of the amount of 0·06 mg. required, so that wholemeal bread provides vitamin B<sub>1</sub> in the diet.

2. *White bread* : 1 oz. provides 72 Cal. and contains 0·02 mg. of vitamin B<sub>1</sub>. Hence sufficient white bread to provide 100 Cal. contains only 0·03 mg. of vitamin B<sub>1</sub>. This is less than the 0·06 mg. needed by the body. White bread is therefore deficient in vitamin B<sub>1</sub> and constitutes a drain on the diet.

3. *National bread* : 1 oz. provides 72 Cal. and contains 0·04 mg. of vitamin B<sub>1</sub>. Hence, sufficient National bread to provide 100 Cal. contains 0·06 mg. of vitamin B<sub>1</sub>. This is equal to the amount of 0·06 mg. required, so that National bread is thus a source of vitamin B<sub>1</sub> in the diet.

If similar calculations are made, it will be found that most natural foods, including potatoes, green vegetables, milk and dairy produce, all add some vitamin B<sub>1</sub> to the diet. *Almost the only foods grossly deficient in vitamin B<sub>1</sub> are white flour, white bread and sugar.* Vitamin B<sub>1</sub> is distributed in foods as shown in the table below :

VITAMIN B<sub>1</sub> CONTENT OF CERTAIN FOODS

mg. per oz.				mg. per oz.			
Dried brewers' yeast	...	...	2·75	National bread	...	...	0·04
Peanuts	...	...	0·26	Potato	...	...	0·03
Bacon	...	...	0·17	Beef	...	...	0·02
Oatmeal	...	...	0·13	Cabbage	...	...	0·02
Green peas	...	...	0·12	White bread	...	...	0·02
Wholemeal bread	...	...	0·07	Milk	...	...	0·01
Mutton	...	...	0·05	Sugar	...	...	Nil

In the manufacture of *beer*, grain is mashed in water, sugar is added, and the mixture is fermented with *yeast*. The yeast, which is a living organism, absorbs the vitamin B<sub>1</sub> from the grain ; therefore brewers' yeast is a particularly good source of this vitamin. It does not, however, absorb riboflavin or nicotinic acid to the same extent and consequently beer contains quite substantial amounts of these vitamins.

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## RIBOFLAVIN

1. Riboflavin is a yellow substance which possesses a green fluorescence in solution. The slight green fluorescence of whey is caused by the riboflavin content. Riboflavin is composed of carbon, hydrogen, oxygen and nitrogen, and (like vitamin B<sub>1</sub>) becomes associated with phosphoric acid in the body and is soluble in water.

2. Its function, like that of vitamin B<sub>1</sub>, is to form a link in the chain of processes through which the body obtains energy from carbohydrate.

3. When insufficient riboflavin is provided by the diet, the following symptoms occur : (i) growth of children is checked ; (ii) cracks and sores appear in the skin at the corners of the mouth ; (iii) the tongue becomes red and sore ; (iv) finally, the transparent front of the eyes may become misted.

Riboflavin is distributed in foods as shown in the table below :

RIBOFLAVIN CONTENT OF CERTAIN FOODS

mg. per oz.				mg. per oz.			
Dried brewers' yeast	...	...	1.54	Wholemeal bread	...	...	0.03
Liver	...	...	0.85	Potato	...	...	0.02
Meat Extract	...	...	0.48	National bread	...	...	0.02
Cheese	...	...	0.14	White bread	...	...	0.01
Egg	...	...	0.11	Beer	...	...	0.01
Beef	...	...	0.07	Sugar	...	...	Nil
Milk	...	...	0.04				

*Among the everyday foods the best sources of riboflavin are dairy produce, eggs and liver.*

## NICOTINIC ACID

1. Nicotinic acid is composed of carbon, hydrogen, oxygen and nitrogen. It is chemically similar to part of the substance nicotine, although nicotinic acid is not derived from nicotine in nature, nor does tobacco-smoking supply the body with nicotinic acid.

2. The function of nicotinic acid is to form another link in the chain of processes through which the body obtains energy from carbohydrate.

3. When there is *insufficient nicotinic acid* in the diet the following signs of ill health occur : (i) growth of children is checked ; (ii) the skin becomes rough and red, especially where exposed to the light, as on the face, hands and neck ; (iii) the tongue becomes red and sore ; (iv) diarrhoea and other signs of digestive upset appear ; (v) mental symptoms develop such as dementia or confusion ; (vi) in severe cases the disease pellagra develops, in which the above symptoms are aggravated.

*Riboflavin deficiency and nicotinic acid deficiency* are frequently present at the same time and some of the symptoms of deficiency may be due to lack of either or both in the diet.

4. A principal source of nicotinic acid is meat, including offals, but it is also present in fish, wholemeal bread and many other foods. Its distribution in foods is shown in the table below :

NICOTINIC ACID CONTENT OF CERTAIN FOODS

mg. per oz.				mg. per oz.			
Meat extract	...	...	17.0	Cod	...	...	0.6
Dried brewers' yeast	...	...	10.3	Beer	...	...	0.4
Liver, kidney	...	...	3.8	Potato	...	...	0.3
Beef	...	...	1.3	National bread	...	...	0.3
Bacon	...	...	1.1	White bread	...	...	0.2
Wholemeal bread	...	...	0.9	Cabbage	...	...	0.1
Peanuts	...	...	0.6				

## THE VITAMIN B GROUP OF NUTRIENTS

### OTHER B VITAMINS

Among the other B vitamins the most important are :

- (1) PYRIDOXIN, also called vitamin B<sub>6</sub>, which is needed for the growth of all young animals. It is concerned in maintaining the health of the skin and is closely connected with protein metabolism. Yeast, liver, cereals and pulses are the best sources, but it is present in smaller amounts in most foods.
- (2) PANTOTHENIC ACID, also concerned with the health of the skin and with growth, is widely distributed in foods, but is found in larger amounts in yeast, liver, meat, cereals and milk.
- (3) BIOTIN is necessary for the health of the skin. In raw egg white there is a substance called *avidin* which interferes with the action of biotin. If large quantities of raw egg white are eaten symptoms of illness occur. Cooked egg white does not have this effect.
- (4) FOLIC ACID is useful in curing macrocytic anaemia and is also required for growth in chicks and monkeys. It is found in liver and green leafy vegetables.
- (5) VITAMIN B<sub>12</sub> is known as the anti-pernicious-anaemia factor. It has recently been isolated, both in Britain and America, from liver and from cultures of a certain group of bacteria. Examination of its chemical structure has shown that, unlike the other vitamins, it contains a metal, *cobalt*. Vitamin B<sub>12</sub> is found in liver, yeast, cereals, pulses and milk.

## CHAPTER XII

### VITAMIN C (ASCORBIC ACID)

In applying the science of nutrition to the practical planning of diets care must be taken to ensure an adequate supply of vitamin C. A proper supply of all vitamins is necessary for an adequate diet, but in many cases individual substances are so widely distributed and required by the body in such small amounts that no problem of supply arises.

For example, vitamin A is present in animal foods, such as dairy produce and eggs, and in vegetable foods such as greens and carrots. Vitamin B<sub>1</sub> is found in almost all foods where it is needed, except white flour and sugar. It is therefore not difficult to design a diet containing enough of these two nutrients, even though this is not always done.

The two facts which make it easy for a diet to be insufficiently provided with vitamin C are :

- (1) Vitamin C occurs mainly in vegetable foodstuffs, i.e. fruit and vegetables, which are often scarce and expensive. Among animal foods are fresh liver, fresh meat and milk, which contain very small amounts.
- (2) Vitamin C may easily be destroyed by cooking. Even if the best methods are used, it is difficult not to lose at least half the amount originally present.

If insufficient vitamin C is provided by the diet, the following ill-effects will arise : (i) growth of children will be checked ; (ii) the gums and mouth become susceptible to infection ; (iii) the healing of wounds and fractures is slowed down ; and (iv) the final result of a continued shortage of vitamin C will be the disease scurvy.

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Vitamin C is very easily soluble in water. In plants, however, the vitamin is enclosed within the vegetable cells. In these cells is also found an enzyme, a substance which works with the vitamin in carrying on the harmonious life of the plant. When plant cells are destroyed by man, either by cooking or by mechanical means such as grating or mincing, the ordered life of the plant is disrupted and the enzyme destroys the vitamin C. This destruction can be minimised by destroying the enzyme itself (see Chapter XVI).

### VITAMIN C CONTENT OF CERTAIN FOODS

	mg. per oz.		mg. per oz.
Blackcurrant ... ..	57	Potatoes :	
Brussels sprouts ... ..	28	New ... ..	9
Cauliflower ... ..	20	October, November ... ..	6
Cabbage ... ..	20	December ... ..	4
Watercress ... ..	17	January, February ... ..	3
Oranges ... ..	16	March onwards ... ..	2
Lemon ... ..	14	Lettuce ... ..	4
Grapefruit ... ..	11	Onion, carrot ... ..	3
		Apple, plum, pear ... ..	1

1. In green vegetables the amount of vitamin C is highest in the spring and early summer when the plants are making rapid growth. For example, brussels sprouts and spring cabbage harvested when they are growing most quickly in the first of the season's warm weather may contain 50 or 60 mg. of vitamin C per oz.

2. When vegetables begin to wilt, either through long storage or other causes, vitamin C is quickly lost.

3. As can be seen from the table, the vitamin C in potatoes decreases during storage. The concentration is highest in July and August when the crop is dug and thereafter steadily falls during the winter and spring. Although the amount of vitamin C in an ounce of potato is never as high as that in other foods, potatoes are usually the principal sources of vitamin C in the diet because quite large amounts of them are eaten, and they are eaten every day. Before potatoes were introduced into Europe, scurvy was a common disease at the end of every winter.

Although blackcurrants, and next to them oranges, lemons, and grapefruit, are among the richest common sources of vitamin C, higher concentrations have been discovered in less common forms. For example :

- (1) Rose hips may contain up to 700 mg. of vitamin C per oz., i.e. 2.5 per cent of the fruit consists of vitamin. The average figure for rose hips is about 170 mg. per oz. Hips cannot be eaten as such, because the fine hairs surrounding the pips irritate the digestive tract. Syrups and other forms of extract can, however, be made from them.
- (2) Unripe walnuts, at about the stage at which they are normally pickled, contain large quantities of vitamin C. The figure to be expected is some 500 mg. per oz. Although this vitamin concentration can be preserved in pickled walnuts, the normal pickled walnuts of commerce usually contain no vitamin C at all.

### *Needs of vitamin C for animals*

If human diet does not contain vitamin C, health will suffer and finally the disease of scurvy will occur. The need for vitamin C is not, however, shared by all animal species. Although guinea pigs, like men, need vitamin C to protect them against scurvy, rats and some other animals can make the vitamin for themselves and can live on a diet entirely devoid of it.

### *Formation of vitamin C*

Except for a few animal foods such as liver and milk, vitamin C is found only in fruit and vegetables. Seeds, including cereal grains and, it is important

## VITAMIN C (ASCORBIC ACID)

to note, dried peas and beans, contain no vitamin C. When seeds have sprouted, however, vitamin C develops in them. In circumstances where normal sources of vitamin C are cut off ill health can be avoided if dried peas or grains are moistened, allowed to sprout, and then eaten in that form.

### *Vitamin C in milk*

A baby can derive enough vitamin C from its mother's milk provided the mother's diet is good, but it is recommended that the baby be given vitamin C in orange juice or some other form to make sure the supply is sufficient. Cow's milk, which soon becomes an important item in the infant's diet, contains a small amount of vitamin C, but in actual practice the following two factors largely determine the value of cow's milk as a source of vitamin C for children :

- (1) The influence of light. Milk contains riboflavin, which in the presence of light quickly causes the destruction of vitamin C. A bottle of milk left for an hour or so in bright morning sunshine is unlikely to retain more than a negligible amount of vitamin C.
- (2) The influence of heat. During pasteurisation of milk, some vitamin C is lost ; there is a still greater loss when milk is boiled.

These losses are not very important, as we do not depend on milk as the sole source of vitamin C. It is a wise dietetic practice to start giving orange juice to infants at an early age.

## QUESTIONS ON PART II

*(Chapters VI to XII)*

1. For what main purposes are inorganic mineral substances used by the body ?
2. What are bones principally made of ?
3. What is the function of salt in the body ?
4. How does the body lose salt ?
5. Why do stokers in steamships like kippers ?
6. What is iodised salt and what is it used for ?
7. A shortage of two different minerals may cause muscular cramp. Which are they ?
8. What purposes does calcium serve in the body ?
9. Which contains more calcium : meat or cheese ?
10. Why can canned salmon be a better source of calcium than fresh salmon ?
11. Why do children have special need of calcium ?
12. What other kinds of people have special need for calcium besides children ? Why ?
13. Why is it necessary to worry more about the amount of calcium in the diet than about the amount of phosphorus ?
14. What is the principal use of iron in the body ?
15. How is iron lost from the body ?
16. Which foods are the best sources of iron ? Is milk a good source ?
17. What sources other than food may provide iron for the body ?
18. What does vitamin A do in the body ? What kinds of food contain vitamin A ?
19. How could you tell by looking at it whether one cabbage contained more vitamin A than another ?
20. Can vitamin A be stored in the body ?
21. Vitamin B<sub>1</sub>, riboflavin and nicotinic acid are all concerned together in one function in the body. What is it ?
22. What purposes does vitamin C serve in the body ? What foods provide vitamin C ?
23. When do potatoes contain most vitamin C and when do they contain least ?
24. What does vitamin D do ? What foods contain it ? How, otherwise than from food, can vitamin D be obtained ?
25. What is phytic acid ? What does it do and which foods contain it ?
26. Under what circumstances is iron best absorbed by the body ?
27. Vitamin B<sub>1</sub> is notoriously lacking in two foods : which are they ?
28. Which are the best sources of riboflavin and of nicotinic acid in the diet ?
29. What is the difference between vitamin A from animal and from vegetable foods ?
30. Why does milk from the dairyman seldom contain any vitamin C at all ?

## PART III

### CHAPTER XIII : DIGESTION OF FOODS & ABSORPTION OF NUTRIENTS

*Food has been defined as anything, either solid or liquid, which when it is swallowed can (i) supply the body with energy, (ii) enable the body to grow, or (iii) regulate the mechanism of the body.*

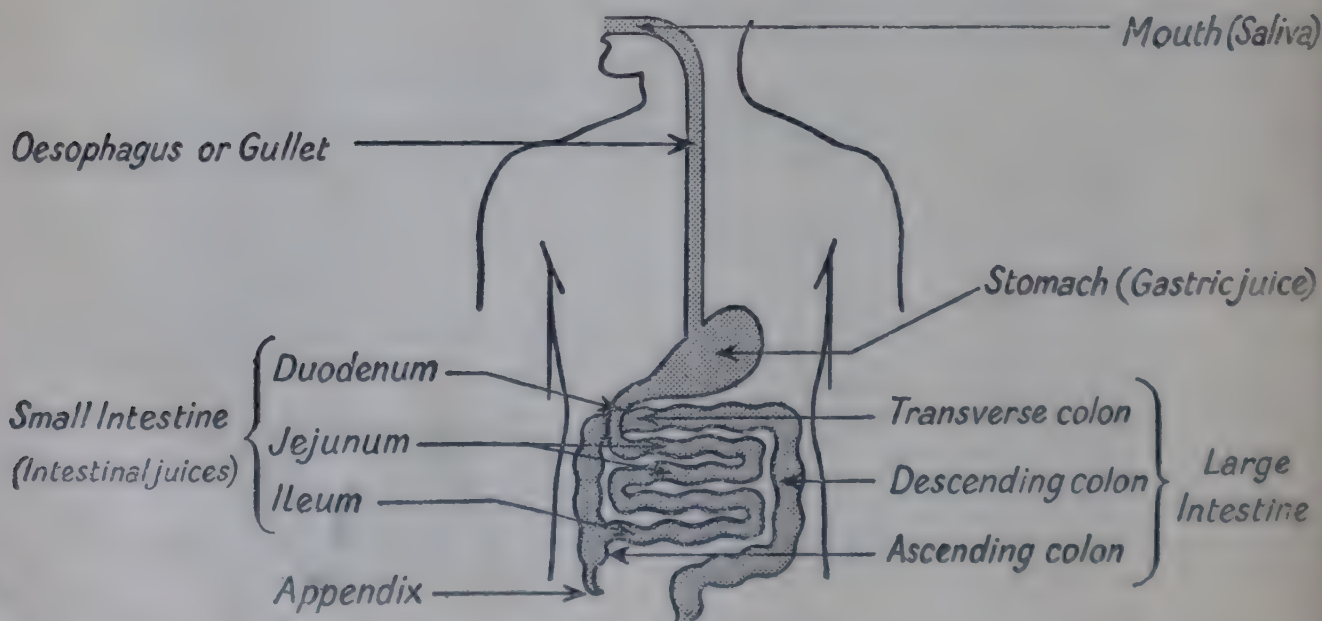
Food can do none of these things until it is *absorbed*. While a piece of bread remains in one's mouth, it has not fulfilled any of the functions of food and can still be spat out. Indeed, substances can travel further than the mouth without necessarily being absorbed. For example, after poison has reached the stomach it can still be recovered if an emetic is given quickly enough. It can thus be said that :

- (1) While nutrients remain unabsorbed they are not properly in the body and can fulfil none of their functions as essential components of food.
- (2) It follows that if food has exerted an influence on the body, whether it be the supply of energy, the stimulation of growth or the regulation of function, it must have been absorbed.

We can say that the body itself, in which the processes of life are found, includes the head, the limbs, the skeleton, the blood system and, in fact, all the parts through which blood flows. Within this living body there lies what, in spite of many elaborations, amounts to a tube open at both ends ; this tube is the *digestive tract*. Only when digested food has passed through the moist sides of the digestive tract into the blood beyond can it be said to have passed into the body.

1. **DIGESTION.** Before the nutrients in food can pass through the walls of the digestive tract into the body, the food must be broken down into its component parts by digestive juices and by the mechanical action of the teeth and other parts of the digestive tract. This process of breakdown is digestion.

2. **ABSORPTION.** This is the process by which separate nutrients and their broken-down products are passed through the walls of the digestive tract into the blood. Only after absorption can the body benefit from food.



THE DIGESTIVE SYSTEM

# DIGESTION OF FOODS AND ABSORPTION OF NUTRIENTS

## A. PROCESS OF DIGESTION

### 1. THE MOUTH :

- (a) Food is mechanically broken down by chewing.
- (b) It is mixed and moistened with *saliva*.
- (c) The saliva breaks down a small amount of cooked starch into the sugar *maltose*.

### 2. THE STOMACH :

- (a) More mixing and mechanical breakdown occurs in the stomach.
- (b) Between 2 and 3 quarts of *gastric juice* are produced each day by a normal stomach. This juice, for the performance of its work, contains 0.2 to 0.4 per cent of *hydrochloric acid*. By the action of gastric juice :
  - (i) Proteins are partly broken down.
  - (ii) Milk is curdled in preparation for digestion.

### 3. THE SMALL INTESTINE :

- (a) *Starch* is broken down to glucose in the small intestine.
- (b) *Proteins*, partly digested in the stomach, are divided into their final units (called amino acids) in the intestine.
- (c) *Fats* are emulsified and the glycerol broken off them so that they may become soluble in water.

4. THE LARGE INTESTINE. Some substances reach the large intestine undigested. The action of bacteria may break down some of these substances such as cellulose. In addition, bacteria use them for their own food.

## B. PROCESS OF ABSORPTION

1. THE MOUTH. Very little is absorbed into the body through the lining of the inside of the mouth.

2. THE STOMACH. The following substances pass in small quantities through the lining of the stomach into the blood behind the lining :

- (a) alcohol, (b) sugar, (c) mineral salts which are soluble in water, e.g. common salt, (d) vitamins which are soluble in water, e.g. B vitamins, vitamin C, (e) water.

3. THE SMALL INTESTINE. The greater part of the absorption of all nutrients takes place in the small intestine : i.e. of (a) carbohydrate, (b) protein, (c) fat, (d) minerals, (e) vitamins, (f) water.

4. THE LARGE INTESTINE. Very little absorption occurs in the large intestine. A small amount of nutrients, freed by bacteria from otherwise indigestible material such as cellulose, is absorbed. Otherwise, one of the principal functions of the large intestine is to absorb water and the remains of the digestive juices from the indigestible residue of foodstuffs which go to form the *faeces* which are finally passed out of the body.

## C. PROCESS OF EATING

1. APPETITE. The thought of food, the sight of it and the savoury smell of an attractive meal causes : (a) saliva to flow into the mouth, and (b) gastric juice to flow into the stomach.

2. DIGESTION IN THE STOMACH. After it has been chewed and mixed with saliva in the mouth, the food is swallowed and passes into the stomach. Different foods stay in the stomach for different lengths of time between 2 and 4 hours, after which period the lower end of the stomach opens and allows squirts of the now semi-liquid food to pass into the small intestine.

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3. DIGESTION IN THE SMALL INTESTINE. The small intestine is a tube one inch in diameter and about 20 feet long, divided and named thus :

- (a) The first 12 inches of intestine nearest the stomach are called the *duodenum* (*duodeni* is Latin for 'twelve at once'). Intestinal juices enter the intestine in the duodenum.
- (b) The next 9 feet of intestine are called the *jejunum* (*jejunus* is Latin for 'empty' : the jejunum is usually found to be empty after death).
- (c) The final 9 or 10 feet of the small intestine make up the *ileum* (*eileos* is Greek for 'twisted').

Food is moved down the whole length of the intestine by rhythmic muscular contraction of the gut walls. Absorption occurs all along the route. The final residue begins to be passed in liquid form, through a valve which prevents any reverse movement, into the large intestine about 4 hours after a meal is eaten.

4. PASSAGE THROUGH THE LARGE INTESTINE. The large intestine is a tube 2 inches in diameter and about 5 feet long. The first part, on the right side of the body, where the faeces travel up, is the *ascending colon*. The portion passing across the body from right to left is the *transverse colon*, and the last main portion on the left side of the body, where the faeces travel down, is the *descending colon*. Faeces are finally expelled from the large intestine through the *anus*. It is quite normal for faeces to leave the body 24 hours or more after the meal from which they were derived.

### ABSORPTION OF WATER

Water never passes 'straight through the body'. When water or watery liquids (such as beer) are drunk, about one-fifth is absorbed into the blood through the stomach and the remaining four-fifths through the small intestine. If an excess of water is taken sufficient to dilute the blood, enough will be withdrawn by the kidneys so that the proper steady composition of blood shall be maintained. This automatic control by the kidneys is so sensitive and rapid that within an hour or less of drinking in excess of the body's needs, the water will have been passed out again through the kidneys.

### HISTORY OF NUTRIENTS IN THE BODY

1. CARBOHYDRATES are partly broken down by saliva in the mouth ; they traverse the stomach and are finally split up entirely into sugars in the small intestine. Thence they pass into the blood. The *digestibility* of carbohydrates in a normal mixed diet is about 98 per cent.

The blood stream carries sugars derived from food to the liver, where they are stored as glycogen (see p. 34). When the body needs energy, the glycogen is converted back to glucose. If the liver already contains a large amount of carbohydrate, part of it may be converted into fat and laid down in the tissues.

During the course of bodily activity, glucose is used up by the muscles. Supplies are consequently transferred by the blood from the liver to the muscles to take the place of the glucose expended.

2. FATS pass unchanged through the mouth and the stomach. In the intestine, however, fat is finely divided until completely emulsified, broken into its constituent parts, and absorbed into the blood. The average *digestibility* of fat is 95 per cent.

When it is in the blood stream, more than half the fat from the food is laid down in the layers of the body's own fat. The remainder is brought to the liver where some of it may be used, together with carbohydrates, for the production of energy.

## DIGESTION OF FOODS AND ABSORPTION OF NUTRIENTS

3. **PROTEINS** pass through the mouth unchanged. They are partly broken down in the stomach and the process is finally completed in the small intestine where absorption of amino acids takes place. The *digestibility* of protein in a mixed diet is about 92 per cent.

The components of proteins pass through the small intestine into the blood and are carried to the liver, where two things may happen :

- (i) If carbohydrate has not been eaten with the protein, the protein will be used for the production of energy ;
- (ii) If protein has been absorbed together with other nutrients, its constituents may be carried to any tissue of the body where there is need for them and there converted into the body's own structure.

4. **MINERALS.** (i) *Soluble salts* such as salts of sodium and potassium are readily absorbed by the stomach and the small intestine. Salts of this nature additional to the body's needs are passed out of the body by the kidneys.

(ii) *Calcium* is absorbed in the small intestine. The proportion of calcium in foods which is unavailable to the body travels through the large intestine and is lost with the faeces.

(iii) *Iron* is only absorbed by the body with difficulty. It passes into the blood through the walls of the small intestine when there is a need for it. Excess iron leaves the body by the large intestine. If much larger amounts of iron are eaten than the body requires, the faeces in which the iron is passed become very dark in colour.

5. **VITAMINS.** (i) *The water-soluble vitamins B and C* are absorbed in the stomach and in the small intestine. Little of these can be stored in the body. If more of them is eaten than is needed to saturate the blood, the excess passes through the kidneys and is lost in the urine.

(ii) *The fat-soluble vitamins A and D* are absorbed only in the small intestine. Excess of these vitamins can be stored in the liver and only in exceptional circumstances is any lost in the urine. If, however, large amounts of, say, undercooked carrots are eaten, the cells of the plant may not be completely digested and part of the vitamin A may be lost in faeces.

### THE DIGESTIVE JUICES

1. **SALIVA** is derived from glands in and under the tongue and in the mouth. Thoughts of food, and the smell and taste of food cause a flow of saliva.

2. **GASTRIC JUICE** is derived from the stomach itself, in the same way that sweat is derived from the skin. Besides *hydrochloric acid*, which has already been mentioned, gastric juice contains *pepsin* which acts specifically to split protein. Gastric juice flows into the stomach when saliva flows into the mouth.

3. **INTESTINAL JUICES.** (i) When food has been digested sufficiently long in the stomach the semi-liquid mixture of food and acid gastric juice begins to pass into the small intestine. The effect of the acid mixture falling on the walls of the intestine causes a substance called *secretin* to be passed into the blood. The secretin is carried by the circulation of the blood to the *pancreas*, an organ connected by a tube to the duodenum. When the secretin reaches the pancreas it causes a digestive juice to be produced which passes into the duodenum.

(ii) A second liquid, *bile*, also enters the duodenum, this time from the liver. Bile breaks fat up into minute globules so that it can be chemically split by the digestive juice from the pancreas.

(iii) A third juice is derived from the walls of the small intestine itself.

# MANUAL OF NUTRITION

## APPETITE, FLAVOUR AND DIGESTION

APPETITE. (i) When the stomach is empty and the body is short of Calories, hunger pains, due to muscular contractions of the stomach, may make themselves felt, and there is a desire to eat.

(ii) The appetising smell of food causes a flow of saliva and gastric juice and the desire to eat, even if there is no cause for real hunger.

(iii) Meat and some other foods contain extractives which, although they are themselves of no food value, cause a flow of saliva and gastric juice and the desire to eat.

Thus, if meals are attractive and appetising and contain tasty 'extractives' there will be a flow of juices and the food will be easily digested. On the other hand, the following factors will reduce the amount of juices and consequently cause delay and difficulty in digestion: (a) unpleasant appearance or smell in the food, and (b) worry, fear or anger before or during eating.

TASTY FOOD AND NUTRITION. Although tasty food stimulates the flow of digestive juices and encourages people to eat, it does not follow that food which people dislike does not nourish them equally well, *provided they eat it*. Indeed, individuals can, if need be, be given the nutrients they require by means of a stomach tube, however strongly they may resent the process. Attractive food has, however, the important nutritional significance of being more likely to be eaten.

## SPEED OF DIGESTION IN THE STOMACH

Some foods remain longer in the stomach than others. While it is commonly considered that foods which pass quickly through the stomach are *more readily digested* than those which do not, it is not necessarily an advantage for foods all to leave the stomach rapidly, because the more quickly the stomach empties the sooner will hunger be felt again.

Fats eaten with other foods possess the power of delaying the passage of those foods through the stomach. For this reason fats are said to possess a high *satiety value*; that is to say they satisfy the appetite longest. A number of average times are given in the following list:

### AVERAGE TIME TAKEN TO PASS THROUGH THE STOMACH

Hours and minutes					Hours and minutes				
Milk	...	...	...	1.00	Fish	...	...	...	3.00
Fruit	...	...	...	2.00	Vegetables	...	...	...	3.00
Sugar, sweets	...	...	...	2.00	Meat (beef, mutton)	...	...	...	3.00
Bread	...	...	...	2.30	Pork	...	...	...	3.30
Egg	...	...	...	2.30					

## BLOOD SUGAR

When any kind of carbohydrate is digested, it is broken down in the small intestine into glucose, in which form it is passed into the blood. The composition of the blood which must be steadily maintained if life is to continue includes normally a small amount of glucose.

This is the fuel for physical activity which is always in transit between the muscles and the liver, where glucose is stored as *glycogen*. When a normal individual eats carbohydrate, the glucose formed from it in the intestine causes a slight rise in the level of blood sugar. This, however, is soon reduced again as the glucose becomes packed away in the liver. *Insulin*, sent into the blood by the pancreas, brings about the *withdrawal of glucose into the liver*.

In the disease of diabetes there is a failure in the supply of insulin and the concentration of glucose in the blood rises steadily until at last it spills over, through the kidneys, and is lost in the urine. This is the reason why untreated sufferers from diabetes are always hungry and often emaciated.

## DIGESTION OF FOOD AND ABSORPTION OF NUTRIENTS

A second substance, *adrenalin*, is produced by two glands, the adrenals, situated close to the kidneys. This, in direct contrast to insulin, causes a *withdrawal of glucose from the liver* and a consequent rise in the concentration of glucose in the blood. This occurs when, for example, a man is angry or frightened. The increase of sugar in his blood would provide fuel for immediate and violent physical action should the reason for his anger or fear demand it.

### ENERGY FROM PROTEIN

A large part of the protein absorbed by the body is used for the production of energy. Digestion in the stomach and in the small intestine finally reduces proteins to their constituent amino acids. These pass into the blood stream which carries them to the liver. There the *nitrogen* contained in amino acids is removed and most of it converted into *urea* which is passed out of the body by the kidneys in the urine. Having lost their nitrogen, the amino acids contain only carbon, hydrogen, and oxygen, and can be used as fuel.

### NUTRITIONAL IMPORTANCE OF THE LARGE INTESTINE

1. The principal function of the large intestine is to *absorb water from the faeces* so that too much moisture is not lost from the body when faeces are passed.

2. A second function of the large intestine is to provide a place for bacteria to act on indigestible fibres so that at least part of them may become available as food. This property is of no great importance to man, most of whose diet is readily digestible. In ruminating animals such as sheep and cattle, whose diet is tough and indigestible, the large intestine is very large indeed and is of some use to them in combination with the rumen, or first stomach, at the other end of the digestive tract.

3. The bacteria in the human large intestine give that part of the gut a third claim to usefulness. These bacteria can make for themselves certain vitamins, notably some of the B group. When diet becomes deficient in these vitamins it is possible partly to replace them by the supply created in the large intestine by the bacteria.

## CHAPTER XIV

### NUTRITIONAL REQUIREMENTS

For proper health and efficiency an individual must eat sufficient of all the nutrients so far discussed. These nutrients are present in varying proportions in a number of different foods. It is therefore possible to design an adequate diet in a number of ways to suit local tastes and diverse food supplies ; but to be satisfactory all these diets must contain the same total amounts of nutrients.

1. OPTIMUM REQUIREMENTS. The figures given on page 37 show the amounts of nutrients which will maintain complete dietary health in the different types of people eating them. These figures are known today as *Recommended Allowances*. Further addition of nutrients would not improve health or efficiency.

2. MINIMUM REQUIREMENTS. If a diet contains less than the optimum requirements of nutrients ill health may not necessarily appear at once. To take an extreme case : if there is just too little to eat (i.e. if there are fewer

## MANUAL OF NUTRITION

than the optimum number of Calories in the diet), an individual will not immediately suffer in health although his efficiency and well-being will be affected. A diet which contains less of each nutrient than the optimum requirement, but just sufficient to prevent an obvious breakdown, can be said to provide the minimum requirements.

### RELATIVE IMPORTANCE OF OBTAINING PRECISE AMOUNTS OF EACH SEPARATE NUTRIENT

1. **ENERGY REQUIREMENTS.** It has been made plain that sufficient food to meet energy requirements must be consumed if physical work is to be done and vigour and weight to be retained over a long period. If too much food is consumed the excess will be stored as fat, while if too little is eaten, and physical activity continues, the body will become thin. The energy value of food is expressed as Calories. The first reaction to a deficit in the Calorie value of the diet is hunger.

2. **PROTEIN.** It was noted in Chapter IV that whereas proteins from most animal foods (e.g. meat, milk, fish, eggs) contain the amino acids essential for the human body, protein from many vegetable sources may be deficient or entirely lacking in one or more of these amino acids. If animal and vegetable proteins are combined in the diet, the result is usually better than when either is included separately. It is therefore impossible to state any definite requirement of animal protein. During its first few months an infant is fed almost exclusively on milk, and is therefore receiving all its protein from animal sources. Later, cereals are added, but most nutritionists recommend that during the growing years, right up to the end of adolescence, about half of the total protein should be from animal sources. The same proportion is recommended for expectant and nursing mothers.

3. **FAT.** There is no hard-and-fast nutritional requirement for fat. If the day's diet is lacking in fat it will tend to become very bulky, fat being the most compact and concentrated of all sources of Calories. Fat is also of great value in making a diet palatable. Without it no frying is possible; cakes and pastries cannot be made; bread cannot be buttered, etc. A working rule can be stated as follows:

- (i) If the daily requirement of Calories is less than 3,000, at least 25 per cent of the day's Calories should be derived from fat. That is to say, if 2,000 Cal. a day are consumed the fat eaten must not be less than 56 g. ( $56 \times 9 = 504$ , i.e. 25 per cent of 2,000).
- (ii) If the day's Calorie needs are more than 3,000 at least 30 per cent of the Calories should be provided by fat. Thus, a man doing heavy labour and taking in 4,000 Cal. must get 134 g. of fat if his diet is to be tolerably palatable ( $134 \times 9 = 1,206$ , i.e. 30 per cent of 4,000).

4. **CALCIUM.** The figures in the table show that 0.8 g. of calcium is needed daily by adults and amounts up to 1.4 g. by children, for full health. Here again is a reason why milk, which is rich in calcium, is particularly valuable for children.

Although the optimum figures given in the table are desirable in a good diet, the minimum amounts of calcium just enough to avoid malformation of bones, bad teeth, or other ill health, can probably be set at half the figures in the table.

5. **IRON.** Although the daily optimum requirement of iron is, in the table, set at 12 mg. for both men and women, it is not easy to say how little iron could safely be eaten just to avoid anaemia. The minimum figure may be lower than the 12 mg. suggested, though it is essential to remember that women probably have a greater need for iron than men since they suffer from a periodical loss of blood.

DAILY ALLOWANCES RECOMMENDED BY THE COMMITTEE ON FOODS AND NUTRITION, NATIONAL RESEARCH COUNCIL, U.S.A. (1945)

NUTRITIONAL REQUIREMENTS

	Calories	Protein	Calcium	Iron	Vitamin A	Vitamin B <sub>1</sub>	Ribo- flavin	Nicotinic acid	Vitamin C	Vitamin D
Man (70 kg.)										
Sedentary ...	2,500	g. 70	g. 0.8	mg. 12	i.u. 5,000	mg. 1.2	mg. 1.6	mg. 12	mg. 75	i.u. *
Moderately active ...	3,000	70	0.8	12	5,000	1.5	2.0	15	75	*
Very active ...	4,500	70	0.8	12	5,000	2.0	2.6	20	75	*
Woman (56 kg.)										
Sedentary ...	2,100	60	0.8	12	5,000	1.1	1.5	11	70	*
Moderately active ...	2,500	60	0.8	12	5,000	1.2	1.6	12	70	*
Very active ...	3,000	60	0.8	12	5,000	1.5	2.0	15	70	*
Pregnancy (latter half)	2,500	85	1.5	15	6,000	1.8	2.5	18	100	400-800
Lactation ...	3,000	100	2.0	15	8,000	2.0	3.0	20	150	400-800
Children up to 12 years										
Under 1 year	100 per kg.	3.5 per kg.	1.0	6	1,500	0.4	0.6	4	30	400-800
1-3 years (13 kg.)	1,200	40	1.0	7	2,000	0.6	0.9	6	35	400
4-6 years (19 kg.)	1,600	50	1.0	8	2,500	0.8	1.2	8	50	400
7-9 years (25 kg.)	2,000	60	1.0	10	3,500	1.0	1.5	10	60	400
10-12 years (34 kg.)	2,500	70	1.2	12	4,500	1.2	1.8	12	75	400
Children over 12 years										
Girls 13-15 years (49 kg.)	2,600	80	1.3	15	5,000	1.3	2.0	13	80	400
16-20 years (54 kg.)	2,400	75	1.0	15	5,000	1.2	1.8	12	80	400
Boys 13-15 years (47 kg.)	3,200	85	1.4	15	5,000	1.5	2.0	15	90	400
16-20 years (64 kg.)	3,800	100	1.4	15	6,000	1.8	2.5	18	100	400

\*For persons who have no opportunity for exposure to clear sunshine and for elderly persons the ingestion of small amounts of supplementary vitamin D may be desirable. Other adults probably have little need for such supplements.

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6. VITAMIN A. The optimum requirement of vitamin A of 5,000 i.u. daily for adults is probably the highest figure ever likely to be required in the most unfavourable circumstances. Again, a reasonable minimum figure of the amount which would just protect an individual against symptoms of deficiency is probably about half the figure in the table, i.e. 2,500 i.u. daily.

The National Research Council expressed their allowance in terms of the carotene content of a mixed diet (one-third animal and two-thirds vegetable). Vitamin A is formed within the body from the carotene present in vegetables. The conversion is, however, not very efficient and only about one-third of the carotene in vegetables is converted into vitamin A. In foods of animal origin the carotene has already been changed into vitamin A.

7. VITAMIN B<sub>1</sub>. The amount of vitamin B<sub>1</sub> necessary varies with the energy requirement; 0.4-0.5 mg. per 1,000 Cal. has been suggested as the desired level. Most foods contain sufficient vitamin B<sub>1</sub> per 1,000 Cal., with the notable exceptions of white flour and sugar; but as this vitamin is water-soluble it is not present in fats extracted from either vegetable or animal sources. For example, there is sufficient in milk but practically none in butter. The amount in bread varies with the extraction rate of flour.

8. RIBOFLAVIN. As in the use of vitamin B<sub>1</sub>, the amount required is proportional to the energy value of the diet. About 0.6-0.7 mg. per 1,000 Cal. should be present. The distribution of riboflavin in foods is not so uniform as that of vitamin B<sub>1</sub>. One of the richer sources is milk containing 2.4 mg. per 1,000 Cal. Liver and kidney are very rich in this vitamin. The amount in bread varies with the extraction rate of flour.

9. NICOTINIC ACID. It has been suggested that about 4.5 mg. per 1,000 Cal. should be present in the diet. Many foods do not attain this balance. Fish, meats and offal are rich sources and the amount may be between 32 and 106 mg. per 1,000 Cal. The amount in bread varies with the extraction rate of flour.

10. VITAMIN C. In the table the desirable daily amount of vitamin C is put at 75 mg. for an adult man and 70 mg. for a woman. The minimum requirement for this vitamin can probably be set at 15-20 mg. If, however, fever occurs, or the body has need to heal wounds, a consumption only up to the minimum level may delay recovery.

11. VITAMIN D. It is not possible to make rigid estimates of the minimum safe amounts of vitamin D because: (1) this vitamin can be formed in the skin by sunlight, and (2) if the diet contains incorrect amounts of calcium and phosphorus the quantity of vitamin D needed will be increased.

### GOOD AND BAD DIETS

In actual practice, diets are not often found to be *deficient in only one nutrient*, although this lack may of course occur. A diet deficient in Calories may easily be deficient in protein as well. Similarly a diet short of protein through, say, lack of meat, can easily be deficient also in iron and nicotinic acid, which are present in substantial amounts in meat. Again, lack of milk in a child's diet may produce a simultaneous shortage of calcium and protein.

Deficiency of some nutrients is felt more quickly than deficiency of others. Thus:

1. Shortage of Calories is immediately felt as hunger.
2. Shortage of protein will take some months to be felt although the body begins to suffer immediately. Growth among children will show a check, anaemia may occur, and a general 'off colour' feeling will result.
3. Shortage of water-soluble vitamins B<sub>1</sub>, C and riboflavin, will also take some time to become evident. Then slothfulness, malaise and minor skin

## NUTRITIONAL REQUIREMENTS

troubles may arise. Part of the great surge of good health felt in early summer is due to an increase in consumption of water-soluble vitamins, principally vitamin C, from the new season's vegetables.

4. A deficiency of vitamin A develops slowly and may take a long time to show in people previously well fed. Stores of vitamin A in the liver will protect an individual from effects of deficient diet for a considerable period.

5. Shortage of iron may also take a long time to show. Iron, like vitamin A, can be stored in the liver. On the other hand, if a diet deficient in iron is eaten, any demand on the body for iron because of bleeding or from other causes may produce anaemia more readily than if diet had been adequate.

6. Shortage of calcium and vitamin D : (a) in infants, serious deficiency of these nutrients will appear as rickets in a few months ; (b) in adults, deficiency may not be obvious for years. In the consideration of calcium on page 18 it was noted that the brittleness of bones of old people is probably a symptom of continuous calcium and vitamin D shortage in the diet.

### AN ADEQUATE DIET

In this chapter precise amounts of eleven nutrients needed for an adequate diet by all types of individuals, from infants to active labourers, have been suggested. Other nutrients exist for which it is not at present possible to provide figures, e.g. :

- (a) there are other vitamin B factors ;
- (b) there may be other vitamins associated with vitamin C ;
- (c) certain fatty acids possess the properties of vitamins ;
- (d) vitamin E and vitamin K, fat-soluble factors, also have dietary importance.

Despite the lack of figures for these and other nutrients, adequacy of diet can be safeguarded by incorporation in it of as wide a variety as possible of natural foods.

Pure vitamin C can be added alone to a diet calculated to be lacking in it, but is better supplied in oranges, watercress or other salads. If these foods are used, some at least of the other nutrients may be supplied.

It has already been remarked that single deficiencies in diets are less common than a shortage of several nutrients together. Deficiency of B vitamins may cause sore tongue and cracks at the corners of the mouth. These have been noted as symptoms of *riboflavin deficiency*, but if pure riboflavin is given the tongue and mouth may be cured and severe dermatitis of the face and hands may break out. These are symptoms of *nicotinic acid deficiency*. It frequently happens that sufferers have been eating a diet deficient in all B vitamins and that by chance the symptoms of only one deficiency occur. If that deficiency only is treated, symptoms of one of the other shortages appear. The correct treatment is to provide a diet fully adequate in all nutrients.

## CHAPTER XV

### COMPOSITION OF FOOD

The detailed composition of food in terms of nutrients is given in the Appendix A and must constantly be referred to in the course of this chapter. It is always important to remember, however, that large variations may occur in different specimens of the same food. The practical implications of this

## MANUAL OF NUTRITION

variability in meat have been referred to in Chapter V and are mentioned again below. Similar if perhaps less extreme fluctuations may also occur in other foods.

1. **CEREALS:** All the common cereals (wheat, oats, barley, rye, maize, rice, etc.) are principally *sources of carbohydrate*. The amount of this nutrient in the whole grain varies from 58 per cent (oats) to 70 per cent (rye). Compared with this, *protein* ranges from 8 per cent (rice) to 13·0 per cent (Canadian wheat) and *fat* from 1·5 per cent (barley) to 4·8 per cent (oats). Cereal grains contain approximately 13 per cent of *moisture*.

In flour milling the term 'extraction rate' means the percentage of flour which is separated from a given weight of wheat. This can be varied according to the type of flour required, giving, for example, pre-war white flour, national flour and brown flours, such as commercial wholemeal.

Brown flours contain a proportion of the tough outer coats of the grain. These contain (a) indigestible fibre which reduces the digestibility of the flour; (b) phytic acid which may combine with some of the calcium in the diet and prevent its absorption by the body. The addition of calcium carbonate to flour, described on page 20, will more than compensate for any such action of phytic acid. Similarly the action of phytic acid present in oatmeal can be counteracted by the customary use of milk or cheese with an oatmeal dish.

White flours consist mainly of the innermost part of the grain, i.e. the endosperm. As the extraction rate of flour rises the digestibility falls but the disadvantages have to be considered in relation to the nutritional advantages. These are: (i) more protein, (ii) more iron, and (iii) more vitamins of the B complex.

In the preparation of national flour, methods were devised so that it would contain as much of these nutrients as possible, and at the same time exclude most of the indigestible parts of the grain. If the whole grain is ground as flour the product is called 100 per cent extraction flour.

2. **DAIRY PRODUCE:** (a) *Milk* is the most complete of all foods but is comparatively deficient in *iron* and *vitamin C*. Besides the nutrients shown in the appendix, milk contains 88 per cent of water. Its carbohydrate is in the form of the sugar, lactose. The composition of milk may vary according to the breed and age of the cow.

*Nutritive Value of Pasteurised Milk.* Both as a liquid and as a food of high nutritive value milk is highly susceptible to the growth of bacteria. One organism which may be present in milk is the tuberculosis bacillus, derived from infected cows. This organism, together with almost all other harmful bacteria, is destroyed by heating the milk to 145°F. Heating milk in this way is called *pasteurisation*, and has no material effect on the nutritional value of milk, as a food. It causes a reduction in vitamin C, of which milk is a poor source, and a very slight reduction in vitamin B<sub>1</sub>.

(b) *Cream* is derived from milk either by allowing the butter fat to rise to the top or by mechanical separation. It contains 18 to 48 per cent of fat, in place of about 3·5 per cent in milk.

(c) *Skim milk* is milk from which most of the fat has been removed. It is a nutritious food owing to the protein, calcium and riboflavin in it.

(d) *Butter* is made from cows' milk by separation of the cream, which is then churned. The principal constituent of butter is the fat, which never falls below 80 per cent by weight: other constituents are butter-milk, which is incorporated into the fat during manufacture, and salt, of which 1 to 2 per cent is added for salted butter. The amount of vitamins A and D in British butter is twice as high in summer, when the cows have grass to eat, as in winter, when they are fed on hay.

## COMPOSITION OF FOOD

(e) *Cheddar Cheese* is composed of one-third protein, one-third fat and one-third water. As can be seen from Appendix A, it is an excellent source of calcium.

Cheeses of various types differ principally because of the different organisms used to cause coagulation of protein during manufacture. Hard cheeses such as the Cheddar and Cheshire varieties, are, in general, of higher nutritive value than soft cheeses such as Camembert and Gorgonzola, because they contain less moisture. Cream cheese has a high fat content.

Certain cheeses are made from milk other than cow's milk. For example, Parmesan, which contains more protein than an average cheese, is made from goats' milk, and Roquefort from sheep's milk.

(f) *Dried Milk*. Dried whole milk is of very high nutritional value and contains almost all the nutrients of liquid milk concentrated by the removal of the water. The fat in it, however, makes it difficult to store for long periods as it may turn rancid. Dried skim milk contains the protein, carbohydrate, calcium and B vitamins from liquid milk, but the fat, and with it vitamins A and D, have been removed. Evaporated milk is a third valuable product containing the nutrients from milk concentrated by the removal of part of the water. Sugar is added in the manufacture of sweetened condensed milk.

(g) *Eggs* are a good source of protein and, particularly, of iron. They also provide substantial amounts of vitamin A, B vitamins and vitamin D.

(h) *Dried egg* contains all the nutrients present in fresh egg, concentrated by the removal of water. When dried egg is reconstituted the resulting mixture is almost identical in nutritional value with fresh egg.

3. MEAT : (a) The lean part of meat is made up of a number of muscle fibres joined together side by side. These fibres differ in length in various types of meat. They are longer in old than in young animals ; they are also longer in crab, for example, than in breast of chicken ; for this reason chicken is more easily digestible than crab.

The outer part of each fibre is made up of tough connective tissue of a gristle-like nature. When a beefsteak is pounded with a stick, the muscle fibres are broken apart so that the digestive juices can more readily get between them, and the meat is consequently made more tender.

*Effect of hanging meat*. When meat is allowed to hang, *acids* develop in it which cause the muscle fibres to soften. The meat thus becomes more tender, and the acids also give it a stronger flavour. This method of softening meat by incipient putrefaction is commonly carried out with game. The desirable flavour of well-hung game would be described as an 'off' flavour for other meats, but such an 'off' flavour would have no ill-effect on the nutritive value of the meat.

Deposits of *fat* are found in spaces between the muscle fibres. Each separate muscle fibre is a tube which contains : (i) water, (ii) soluble protein, (iii) mineral salts, and (iv) extractives.

*Extractives* do not of themselves provide much nourishment, but they give meat its flavour, and they exert a powerful influence in causing a flow of juices in the digestive tract.

The nutrient composition of various types of meat is shown in Appendix A. There is not necessarily more nourishment in expensive meat than in cheaper kinds, nor has frozen meat any lower value than fresh meat. Corned beef has, however, lost a proportion of its nicotinic acid and riboflavin. These nutrients reappear in meat extracts which are by-products of the manufacture of corned beef.

(b) *Liver* and *kidney* contain less fat than most meat. Liver, particularly, is very rich in vitamin A, and is also a very good dietary source of iron.

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(c) *Sweetbread* and *tripe* are useful and easily digestible sources of animal protein. Tripe contains much more calcium than other meats ; this is derived from the lime with which tripe is treated during preparation.

4. FISH : (a) The muscle of fish is as useful a source of animal protein as meat. The fat of fish, unlike fat in meat, provides vitamins A and D in the diet. As can be seen in Appendix A the proportion of fat in different types of fish varies widely. *Fat fish* (herring, mackerel, salmon, eel) contain from 5 to 18 per cent of fat. *White fish* (cod, haddock, sole, whiting, etc.) contain less than 2 per cent of fat.

(b) Those fish of which the bones are eaten provide an excellent source of calcium and phosphorus. This group includes whitebait, sardines, and sprats. The practice of eating the backbone of canned salmon adds calcium to the diet.

5. VEGETABLES : (a) *Green vegetables* are of nutritional importance because of the vitamin C and vitamin A they contain. The figures given in the appendix are average values ; individual specimens may vary widely in composition. Vitamin C content is highest in the early summer. Vitamin A is increased in proportion to the greenness of the vegetable. Green vegetables provide few Calories, only a trace of fat and a small amount of protein. Owing to their high water content they are bulky foods. They also contain a comparatively large amount of indigestible fibre.

(b) *Root Vegetables*. The most important of these are *potatoes*. When large amounts of potatoes are eaten, the amount of Calories obtained is substantial. The protein is also a useful contribution to the diet. In many diets potatoes provide most of the vitamin C. *Carrots* have already been mentioned as exceptional among roots in containing a large amount of vitamin A. The *sweet potatoes* grown in America also contain vitamin A. *Turnips* and *swedes* contain vitamin C but are otherwise of little nutritive value. They contain 91-93 per cent water, which is more than the amount found in milk (88 per cent water) or average soup (90 per cent water).

(c) *Peas and Beans*. Green peas and broad beans contain more Calories and more protein than other vegetables. They also contain iron, vitamin B<sub>1</sub> and vitamin C ; green peas provide vitamin A.

Dried peas and beans must not be confused with fresh vegetables. They contain no vitamin C and negligible vitamin A. As will be seen from the appendix, the dried forms are rich in Calories, protein, and other nutrients. It is, however, important to remember that before they can be used, dried peas and beans must be soaked. When this is done the moisture content rises from 7 to 68 per cent ; in peas the Calories (to take a single nutrient value) fall from 85 to 26 per oz.

6. FRUIT : (a) *Fresh fruit*, when ripe, contains sugar, which makes it sweet. but the main nutritive importance of fruit is as a source of vitamin C. In the appendix it will be seen that, except for blackcurrant, orange, strawberry and one or two others, fruits do not compare very favourably with vegetables as a source of vitamin C.

(b) *Dried fruits* such as currants, raisins, dates and figs provide Calories principally in the form of sugar. Prunes and dried apricots are also useful sources of vitamin A. Dried fruits do not contain vitamin C.

(c) *Nuts* are highly nutritious ; rich in protein and fat, they are a concentrated source of Calories. They contain no vitamin A, or vitamin C, but are unusually rich in vitamin B<sub>1</sub>. Nuts are not easily digested because they contain high proportions of tough fibres.

# COMPOSITION OF FOOD

## QUESTIONS ON PART III

(*Chapters XIII to XV*)

1. What is meant by the absorption of food ?
2. A dishonest pearl-diver is trying to steal a pearl. He swallows it. Is the pearl digested ? Does it become absorbed ?
3. What is the purpose of saliva in the mouth ?
4. In which part of the digestive tract does the digestion of protein take place ?
5. What foods are absorbed through the stomach ?
6. Where does the absorption of most of the nutrients from food occur ?
7. What is the purpose of the large intestine ?
8. Beer is mostly water. If more beer is drunk than a body really needs how is the excess of water disposed of ?
9. What proportion of the carbohydrate, protein and fat from a normal diet is digested ?
10. A coal miner is eating 2,000 Cal. a day. Is this enough ?
11. A lady living in Cheltenham regularly eats 3,500 Cal. a day. What will happen to her ?
12. Who needs most protein, a child of 10, a bricklayer, an expectant mother, a girl of 15, or a boy of 20 ?
13. Why is milk specially good for children ?
14. How much vitamin A and vitamin C should a good diet contain ? How little is it safe to allow when supplies are scarce ?
15. What is the difference between white bread and brown bread ?
16. What nutrients does milk not contain ?
17. What nutrients does meat supply ?
18. What is the main difference between mackerel and whiting ?
19. Which provides most vitamin C, an ounce of cabbage, carrot, onion, potato or haricot beans ? Which provides most vitamin A ?
20. What part does the liver play in the digestion of food ?
21. What circumstances are likely to produce good appetite ? Why ?
22. What is 'satiety value' and which foods contain most ?
23. What will be felt first, a shortage of protein, iron, vitamin A, Calories or vitamin C ? What is the final effect of iron deficiency ?
24. What nutritional disadvantages are there about brown bread that white bread does not possess ?
25. What is the difference between raw and pasteurised milk ?
26. How many grams of fat ought there to be in a diet the total calorific value of which is 4,200 ?
27. Why is it better nutritional practice to provide orange juice than pure vitamin C ?
28. What are the complete nutritional requirements of a boy of 12 ?
29. Which groups of people have the greatest need for animal protein ?
30. What is the nutritional requirement of fat ?

## PART IV

### CHAPTER XVI : COOKING

The process of cooking almost always directly improves the nutritional value of foods, and also performs the important secondary function of improving the flavour and attractiveness of foods.

When food is unpleasant, people will often eat less of it than their bodies need. Nutritional health must of course suffer if insufficient nutrients are absorbed because too little is eaten. Besides encouraging people to eat more, well-cooked food assists in *digestion* and *absorption* by increasing the flow of digestive juices in the mouth and stomach.

#### COOKING METHODS

Cooking always involves the use of heat applied in one of three ways :

- (a) *Baking, roasting and grilling*, which involve the use of *dry heat* applied direct to the food.
- (b) *Boiling and steaming*, which apply heat by means of *hot water*.
- (c) *Frying*, which utilises the high degree of heat available from *hot fat*.

#### EFFECT OF COOKING ON SEPARATE NUTRIENTS

1. **CARBOHYDRATE.** Cooking is essential for proper absorption of starch, which is by far the most important source not only of carbohydrate but also of Calories in the diet. The starch in uncooked flour, potato, rice or oatmeal has already been described in Chapter II as enclosed in starch granules which are highly resistant to the human digestive juices. When heat is applied in any method of cooking—the baking of flour for bread, the boiling of potatoes, or the frying of a flour batter with fish—the starch granules swell up and burst and the starch itself becomes *gelatinised*, in which condition it can be completely digested and absorbed.

2. **PROTEIN.** Application of heat to proteins causes *coagulation*, a process most strikingly demonstrated by the white of a boiled egg. A second effect of heat on many proteins is *shrinking*. During grilling, for example, a steak shows pronounced shrinkage because of contraction of the protein of the muscle fibres. The digestibility of moderately cooked protein is, in general, greater than that of raw protein. For example, the absorption of raw egg is low. *Excessive exposure to heat*, however, will eventually reduce the nutritive value of protein.

3. **FAT.** Cooking has little effect on fat.

4. **MINERAL SUBSTANCES.** (i) *Calcium.* Cooking may work in two ways on calcium in foods. Neither is a factor of great importance. In milk, for example, heat may cause a slight reduction in the availability of calcium to the body, whereas in cereals the small amount of calcium present may become more available.

An indirect effect of cooking on the amount of calcium in foods is that of the calcium in 'hard' cooking water. For example, if greens are boiled in 'hard' water, sufficient calcium may become incorporated in them to double the amount they originally contained. Calcium is deposited when 'fur' accumulates in a kettle.

(ii) *Iron.* In general, cooking tends to increase the ease with which the body can absorb iron from foods. A second beneficial aspect is the increase in dietary iron due to amounts picked up from cooking water and utensils.

## COOKING

On the other hand, iron may be lost during the cooking of meat if juices containing it are allowed to escape.

(iii) *Sodium*. Salt (sodium chloride) may be lost from foods when they are boiled. This is of little nutritional significance, as salt is always added during cooking.

(iv) *Aluminium*. Although very minute traces of aluminium are to be found in the human body, so far as is known it plays no part in any life process, and is of no use in nutrition. The small amounts normally acquired from aluminium vessels are completely harmless.

5. VITAMINS. (i) *Vitamin A and vitamin D* are not affected by cooking. The amount of heat used does not damage either nutrient, and as they are insoluble in water, no losses occur during boiling.

(ii) *Vitamin B<sub>1</sub>*. A proportion may be destroyed during cooking for the following reasons :

(a) Although vitamin B<sub>1</sub> can stand some degree of heat, it is *destroyed at high temperatures*, e.g. during the baking of biscuits and the manufacture of some breakfast cereals.

(b) Vitamin B<sub>1</sub> is *destroyed by baking-soda*. There is little loss during the baking of yeast buns or bread, but almost complete destruction in soda buns or soda bread.

(c) Since vitamin B<sub>1</sub> is soluble in water a proportion is lost in the cooking water during boiling.

(iii) *Riboflavin, nicotinic acid*. Although these vitamins are susceptible to high degrees of heat and are also soluble in water, losses are small during the ordinary process of cooking. Unusually vigorous treatment, such as the 'corning' of beef, causes losses of riboflavin and nicotinic acid.

(iv) *Vitamin C*. It has been shown that cooking is essential to make potatoes (often the most important dietary source of vitamin C) available to the body. This vitamin is, however, readily destroyed by cooking processes, and a proportion is inevitably lost during the culinary preparation of food.

Factors causing loss of vitamin C are :

(a) Long storage of fruit and vegetables.

(b) Prolonged heat (long cooking).

(c) Heat in the presence of air (keeping meals hot).

(d) Vitamin C is very easily soluble in water (it is lost when cooking liquors are discarded).

(e) Vitamin C is quickly destroyed by plant enzymes (released by grating vegetables, or by starting to boil vegetables in cold water).

(f) Copper. If minute amounts of copper become dissolved in milk from dairy utensils or pasteurising machinery or from water used to wash pails and equipment, vitamin C will be destroyed.

### EFFECT OF COOKING ON SEPARATE FOODS

1. CEREALS. *The Baking of Bread*. When bread is made with yeast, part of the starch is fermented to produce the gas carbon dioxide which causes the dough to rise. In the course of fermentation alcohol is also formed. This alcohol evaporates and is lost during baking ; it has been calculated that at least 300,000 gallons of alcohol are lost each year in the ovens of London alone.

Effects of cooking on cereals :

(a) The starch granules burst and thus render the starch in them digestible.

(b) When yeast is used there is little loss of vitamin B<sub>1</sub>. If, however, baking powder is used a substantial loss occurs.

(c) When high temperatures are used, for example in the baking of biscuits, most of the vitamin B<sub>1</sub> is destroyed.

2. MEAT. Effects of cooking on meat :

(a) The muscle fibres of the meat become softened.

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- (b) The meat contracts and some loss of mineral salts occurs.
- (c) There is no material loss of nicotinic acid or other vitamins.
- (d) The iron becomes more available to the body.

3. FISH. Effects of cooking on fish are similar to those on meat. When fish is fried in batter the nutritional value is increased by the addition of fat and by the flour and other ingredients of the batter.

4. VEGETABLES. The principal purposes of cooking vegetables are :

- (a) To soften the cellulose framework.
- (b) To break the starch granules and thus render the starch capable of digestion and absorption by the body.

*Potatoes* have already been described as one of the most important sources of vitamin C in the diet. As vitamin C is susceptible to heat and also soluble in water, it is inevitable that certain losses of the vitamin occur when potatoes are cooked, but it has already been emphasised that without cooking they are uneatable. The extent of the losses are shown below :

<i>Potatoes</i>						<i>Average loss of vitamin C</i>
Boiled in their skins	...	...	...	...	...	15 per cent
Baked in their skins	...	...	...	...	...	20 per cent
Fried ...	...	...	...	...	...	30 per cent
Boiled after peeling	...	...	...	...	...	50 per cent

*Green Vegetables.* About 75 per cent of the vitamin C in green vegetables is lost during cooking. Part of the vitamin is destroyed by heat, part is lost in the cooking water, and part destroyed by the plant enzymes before the temperature is raised sufficiently high to destroy them. If green vegetables are boiled by putting them into cold water and then raising the temperature to the boil, the loss of vitamin from action of enzymes may be three times as high as it would have been had the vegetables been plunged into boiling water and their enzymes destroyed immediately.

*Useful Rules for Cooking Fresh Vegetables :* (a) use fresh ; (b) peel thinly ; (c) prepare just before cooking ; (d) use saucepan with tightly fitting lid ; (e) cook in small amount of boiling salted water ; (f) never use bicarbonate of soda ; and (g) serve immediately.

### STOCK AND SOUPS

*Stock* is extensively used in cooking ; it is commonly made by boiling meat bones in water and has almost no nutritional value. The hot water extracts only a small amount of fat and gelatin from the bone marrow, with a small quantity of extractives which provide flavour and cause the digestive juices to flow. Stock does, however, provide a certain amount of riboflavin and nicotinic acid.

*Nutrition is a quantitative science.* Nutrients must not only be present in food ; they must also be present in adequate and measurable amounts. *Stock* and *soup* cannot be of substantial value unless foods supplying the nutrients, carbohydrates, fats, proteins, minerals or vitamins are put into them. Hot water and flavour have of themselves no food value, but if meat, vegetables, barley and peas are put into soup it can be of substantial nutritional value, although it always remains a comparatively bulky food. Cream soups which are made from milk, fat, flour and vegetable *purées* can contribute substantially to the nutritive value of a meal.

### JELLIES

The protein gelatin, as has already been said, completely lacks the essential amino acid *tryptophane*. Gelatin, however, has the property of causing a very large volume of water, in relation to the weight of gelatin, to form a gel.

## COOKING

The maximum amount of jelly which could be eaten in one day would be about 1 pint. This would contain about 1 oz. of gelatin which would only provide about 110 Calories. The nutritional value of jelly, be it 'calves' foot', 'neat's foot', or 'aspic', can thus be seen to be negligible.

## SALADS

The loss of about 75 per cent of the vitamin C in green vegetables is almost inevitable during cooking. This loss can be almost completely avoided by eating the vegetables raw in the form of salads. It is, however, important to remember the quantitative aspect of nutrition before recommending the use of salads as a diet.

	Vitamin C mg.
1. A convenient serving of lettuce weighs 1 oz. and provides	4
2. A convenient serving of raw cabbage weighs 1 oz. and provides ... ..	20
3. A convenient serving of cooked cabbage weighs 6 oz. and provides ... ..	30

From the figures shown above it can be seen that the consumption of a substantial helping of cooked greens is a better source of vitamin C (and a very much better source of vitamin A) than a serving of raw greens, because the raw vegetable is very much bulkier to eat.

## MEAT EXTRACTS : YEAST EXTRACTS

Meat extracts were, until a short time ago, thought to provide only flavouring material ; it is now known that they provide substantial amounts of nicotinic acid and riboflavin (see p. 26). Yeast extracts also provide a meaty flavour ; they have long been known to contain high concentrations of all the B vitamins.

## CHAPTER XVII

## MEALS

A meal can be arbitrarily defined as an amount of food eaten during a single space of time and providing 200 Cal. or more. This definition includes a great deal more than is generally accepted as the meaning of the word 'meal', which, in its popular sense, is usually restricted to the consumption of cooked and hot food by a person or persons sitting down.

## NUMBER OF MEALS A DAY

For many types of work, the efficiency of the body is best maintained by five or six meals during the day rather than by two or three. There is no fixed rule as to how nutrients may best be distributed through the day ; different conditions of work will effect the most suitable arrangement. Although the amount of nutrients in different meals may vary, the total amount of each nutrient eaten during the day must, of course, reach requirement figures if the diet is to be fully adequate for health.

## EXAMPLES OF PEOPLE EATING DIFFERENT NUMBERS OF MEALS

1. *Three meals a day*  
(a) Some office workers : Breakfast 8 a.m. ; dinner 1 p.m. ; supper 7 p.m.
2. *Four meals a day*  
(a) Some coal miners : Breakfast 5.30 a.m. ; snack 11 a.m. ; dinner 3 p.m. ; supper 8 p.m.  
(b) Many industrial workers : Breakfast 7 a.m. ; dinner 12 ; tea 6 p.m. ; supper 9 p.m.

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### 3. Five meals a day

- (a) Miners (Yorkshire) : Breakfast 4.30 a.m. ; bait 9.30 a.m. ; dinner 3 p.m. ; tea 6 p.m. ; supper 9.30 p.m.  
 (b) Some railway workers : Breakfast 5 a.m. ; snack 8 a.m. ; snack 1 p.m. ; dinner 4 p.m. ; supper 9 p.m.  
 (c) Shipbuilders : Breakfast 7 a.m. ; piece 9.30 a.m. ; dinner 12 ; tea 6 p.m. ; supper 10 p.m.

### 4. Six meals a day

- (a) Many industrial workers : Breakfast 7 a.m. ; snack 9.30 a.m. ; dinner 12 ; snack 3.30 p.m. ; tea 6 p.m. ; supper 9.30 p.m.  
 (b) Cotton spinners : Breakfast 6.30 a.m. ; snack 9 a.m. ; dinner 12.30 p.m. ; snack 3 p.m. ; tea 6 p.m. ; supper 10 p.m.  
 (c) Steel rollermen : Breakfast 5.30 a.m. ; snack 8 a.m. ; snack 11 a.m. ; dinner 3 p.m. ; tea 6 p.m. ; supper 10 p.m.

## CALCULATING THE COMPOSITION OF MADE DISHES

In the appendix the composition is given of foodstuffs in terms of nutrients. The determination of the nutritional value of made dishes is usually a matter of arithmetic based on the figures given in the table. For example, the nutritional value of a cake is computed below :

Foodstuff	Quantity oz.	Calories	Protein g.	Fat g.	Calcium mg.	Iron mg.	Vitamin A i.u.	Vitamin B <sub>1</sub> mg.	Riboflavin mg.	Nicotinic acid mg.	Vitamin C mg.	Vitamin D i.u.
Margarine ...	3	654	0	72.6	3	0.3	1,500	0	0	0	0	270
Sugar ...	3	324	0	0	0	0	0	0	0	0	0	0
Eggs ...	3.25	146	11.4	10.7	55	2.9	923	0.13	0.36	0	0	55
Flour ...	8	776	27.2	3.2	328	4.0	0	0.56	0.16	4.0	0	0
Water...	1.25	0	0	0	0	0	0	0	0	0	0	0
Salt ...	Pinch	0	0	0	0	0	0	0	0	0	0	0
Weight of Cake ...	16.5†	1,900	38.6	86.5	386	7.2	2,423	0.69	0.52	4.0	0	325
Composition per oz....	—	115	2.3	5.2	23	0.4	147	0.03*	0.03	0.2	0	20

† The total weight will not be the same as the sum of the ingredients owing to the loss of moisture in baking.

\* Say 25 per cent to be deducted to allow for loss in cooking.

If the values per oz. calculated above are compared with the figures for cake given in the appendix a number of differences will be found. This again exemplifies the facts, pointed out at the beginning of Chapter XV, that figures for food composition given in tables are only average values. A foodstuff such as cake depends for its nourishing qualities on the amounts of components of high nutritional value put into it.

## CALCULATING THE COMPOSITION OF MEALS

It is quite common to find that in a factory *two* 'communal' meals are provided during the morning. The first, let us say, consists of a 'cheese roll' and a cup of tea. Where there is ignorance of nutrition this could be forgotten or, at least, not considered to be a meal at all. The second might consist of roast mutton, cabbage and potato, followed by stewed apples and custard.

The nutritional value of two such meals has been calculated below from the figures given in the appendix :

I

Foodstuff	Quantity oz.	Calories	Protein g.	Fat g.	Calcium mg.	Iron mg.	Vitamin A i.u.	Vitamin B <sub>1</sub> mg.	Riboflavin mg.	Nicotinic acid mg.	Vitamin C mg.	Vitamin D i.u.
Roll* ...	3.5	252	8.8	1.1	105	1.4	0	0.14	0.07	1.1	0	0
Butter ...	0.3	63	0	7.0	1	0	340	0	0	0	0	5
Cheese ...	2.0	234	14.2	19.6	460	0.4	738	0.02	0.28	0.2	0	8
Tea ...	10.0	50	1.0	1.0	50	0	40	0	0.10	0	0	0
Total Meal	—	599	24.0	28.7	616	1.8	1,118	0.16	0.45	1.3	0	13

\* Calculated as National bread.

## MEALS

2

Foodstuff	Quantity oz.	Calories	Protein g.	Fat g.	Calcium mg.	Iron mg.	Vitamin A i.u.	Vitamin B <sub>1</sub> mg.	Riboflavin mg.	Nicotinic acid mg.	Vitamin C mg.	Vitamin D i.u.
Mutton	2.4	226	8.9	21.1	7	1.4	34	0.12	0.12	2.9	0	0
Cabbage	3.0	21	1.2	0	54	0.9	765	0.06	0.06	0.3	15	0
Potatoes	4.0	84	2.4	0	8	0.8	0	0.12	0.08	1.2	10	0
Apples	3.0	36	0.3	0	3	0.3	33	0.03	0	0.3	2	0
Custard	2.0	62	1.8	2.2	70	0	60	0.02	0.06	0	0	0
Total Meal	—	429	14.6	23.3	142	3.4	892	0.35	0.32	4.7	17*	0

\* 75 per cent deducted from cabbage and 50 per cent from potato and apple to allow for cooking loss.

These calculations show that Meal 1, which might thoughtlessly be dismissed as a mere 'snack', is in many ways of far higher nutritional value than the hot Meal 2. Thus it provides : (a) over 30 per cent more Calories ; (b) almost twice as much protein ; and (c) four times as much calcium and almost as much vitamin A.

The single nutrient in which the second meal was markedly superior to the first was vitamin C. If the cheese roll had included chopped cabbage or watercress or had been accompanied by an orange, it would have been in every way nutritionally a better meal than the meat, vegetables, and sweet. This need not, of course, always be when 'packed' meals are compared with 'cooked' meals. Whether it is or not depends on the quantities and the nutritional composition of the items chosen for each meal.

### THE OSLO MEAL

Given reasonable opportunity, people will eat as many Calories as they need, because if they do not they feel hungry. Foods which provide a cheap and easy source of Calories are white bread, sugar, cakes and the like. These provide Calories it is true, but they do not provide animal protein, calcium, iron, vitamin A, B vitamins, vitamin C or vitamin D. If children are sent to school in the morning with only bread and butter and are given only cheap and filling foods when they come home at night, their day's diet will be inadequate.

It was in order to counterbalance such inadequacy that the Oslo meal was devised. This is a modified form of the 'Oslo Breakfast' introduced in Oslo in 1925. Normally, the people of Norway have only one cooked meal a day, eaten between 3 and 5 p.m. ; their other meals consist of open sandwiches and a drink. Many children used to go to school without an adequate breakfast and had only a few sandwiches to eat until they got home. If a hot midday meal was provided at school many of the children got two large meals in quick succession and very little else during the rest of the day.

It was therefore suggested that the schools should be opened earlier, so that the children could have a good meal before they started work. This meal consisted of  $\frac{1}{2}$  litre of milk, wholewheat bread, butter or margarine, cheese, one scraped raw carrot or half an apple, orange or banana.

In England this was modified into the 'Oslo Meal' and served in place of a hot school meal. The Oslo Meal was made up as follows :

- Milk and cheese* to provide animal protein, calcium and vitamin A.
- Herring or sardine* to provide animal protein, vitamin A and vitamin D.
- Wholemeal biscuit or brown bread* to provide B vitamins and iron.
- Butter or vitaminised margarine* to provide vitamin A and vitamin D.
- An orange and a carrot* to provide vitamin C and vitamin A.

This meal was devised to supply those 'protective factors' in which the remainder of the diet of a poor child was most likely to be deficient.

# MANUAL OF NUTRITION

## WASTE

In studying the composition of meals, the information wanted is the amount of each nutrient actually eaten. When the nutritional value of the meals, and hence of the total diet, of any individual has been worked out it is possible to compare the values with the known requirements for health. It is important to remember, however, that it is not permissible to calculate directly the nutritional value of a diet either (*a*) from the total amounts of foods brought from the shop, or (*b*) from the amounts used in the kitchen. There is always a proportion of waste for which allowance must be made. Waste may occur at three stages :

- (1) Potato peelings, bacon rind, bones from meat, crusts cut off bread, outer leaves of cabbages, etc.
- (2) Fat lost on pans, etc., batter left in mixing bowls, crumbs in bread bins, etc.
- (3) Scraps left on plates, bread, etc., wasted at table.

Before calculating the nutritional adequacy of any diets allowances must be made for wastage, unless it is possible to adopt the more satisfactory procedure of measuring the amounts of edible food actually eaten. The average loss often taken for wastage in cooking and from plates is 10 per cent, but, of course, the figure varies according to circumstances. Over and above this, domestic loss, an additional deduction must be made for skins, bones, stones, outer leaves, shells, etc., in order to arrive at the edible weight when starting from the weight purchased. Average figures for this second loss are given in the first column of the table in Appendix A.

## EATING BETWEEN MEALS

As already shown, people who work in different industries in England may eat their day's diet in three, four, five or six meals. There seems little nutritional difference between these diverse habits. Each may be equally good under different circumstances. Similarly, there seems to be no important nutritional arguments for or against eating small quantities of food between meals, provided that the day's total consumption of nutrients is not prejudiced. But if children eat sweets, which are largely composed of sugar and provide no other nutrient than carbohydrate, between meals, so that they have no appetite for cabbage or for meat at dinner later, the consumption of sweets may then have caused a deficiency of vitamin C or of protein which could have been obtained from the cabbage and meat.

## WORKING BEFORE BREAKFAST

The efficiency of the muscles is lowest in the morning before the first meal of the day. It is, therefore, good nutritional practice to eat breakfast before starting work. It has been shown that more efficient work is done when a good cooked breakfast has been eaten.

## SCHOOL MEALS

The most appropriate nutritional composition for any meal will, of course, be influenced by the other meals which go with it to make the day's diet. People who plan the midday meal for schoolchildren usually assume that a simple breakfast will be eaten in the morning and a tea of bread and jam or some similar combination be eaten at night. The midday dinner ought, therefore, together with school milk, to provide a major proportion of the day's needs of animal protein, much of the vitamin A, most of the vitamin C and sufficient fat for the meal to be compact enough to supply with these nutrients a substantial number of Calories.

## MEALS

A composition for a school meal, based on these assumptions, is :

Age			Calories	Animal Protein	Fat	Vitamin A	Vitamin C
				g.	g.	i.u.	mg.
For a child of 11 plus	...		1,000	20-25	30	3,000	50
„ 8-11	...		750	20-25	30	2,500	40
„ 5- 8	...		650	20-25	30	2,000	30

Schoolchildren are growing and have very high nutrient requirements. It is, of course, important to ensure that their diet is adequate. Where there are reasonable grounds for doubt about a child's home diet it is advisable to plan for the school meal, together with school milk, to provide two-thirds of the vitamin and mineral needs of the day and the major proportion of the animal protein required. The meal must, however, be compact to fulfil the nutritional targets. This necessitates a careful selection of foodstuffs and use to the fullest possible extent of foods of concentrated value, such as dried skim milk.

## CHAPTER XVIII

### HOW TO PLAN BALANCED MEALS

The amounts of nutrients needed daily for health by every type of individual were discussed in Chapter XIV. The figures given there showed the results to be aimed at when a diet was being planned. There are many combinations of food which can be devised to provide these specified amounts ; experience and custom often obtain results which are satisfactory nutritionally as well as popular and palatable.

There are, however, three principles that should always be followed in planning meals to ensure that each is balanced nutritionally :

- (i) *See that the building foods are well represented.*
- (ii) *Make sure that the protective foods are included.*
- (iii) *Let appetite determine how much of the energy foods are to be added.*

### FEEDING YOUNG CHILDREN

For the first few months of their lives infants can live very satisfactorily on their mothers' milk. If they must be given cows' milk, this can easily be modified by the addition of sugar and water to provide the appropriate amounts of carbohydrate, protein and fat.

Although, as can be seen from the appendix, milk is a remarkably complete food it is not perfect in every respect for a growing child. For example :

(a) *Cows' milk is deficient in vitamin C.* Babies must be given orange juice or some other source of vitamin C, if milk is their main food.

(b) *Vitamin A and vitamin D are present in milk but not in sufficient amount for the child as it begins to grow ;* supplements, such as cod liver oil, must therefore be added to it.

(c) *Milk is notoriously lacking in iron.* When it is born, a child usually possesses sufficient iron stored in its liver to keep going for some months. It is, however, important not to delay too long before beginning to feed small amounts of sieved greens and other foods in order to provide the infant with this nutrient. *Eggs*, which are rich in iron and provide animal protein, vitamin A and vitamin D, are an excellent early food for infants.

# MANUAL OF NUTRITION

## FEEDING SCHOOLCHILDREN

Three points are of great importance when diets for schoolchildren are considered :

1. Schoolchildren are growing fast and therefore have great need for protein, calcium, vitamin A, vitamin C and vitamin D. The actual figures can be seen in Chapter XIV.

2. Schoolchildren are very active and therefore have for their size, greater need for Calories than adults. Children's big appetites almost always reflect a real nutritional need, not greediness.

3. Owing to the fact that their size and thus the size of their stomachs is small and at the same time their nutrient needs are large, it is important that the meals they are given shall not be too bulky. Cheese, meat, eggs, fruit and green vegetables are all important to supply children with the nutrients they need. Bread and, particularly, cake made with fat, sugar, milk and eggs are excellent as concentrated sources of Calories. Of all other foods, milk is the best source for schoolchildren of protein, calcium and vitamins A, D and riboflavin.

## FEEDING ADOLESCENTS

The total nutrient needs of adolescents are higher in many respects than those of any other group of people. Healthy adolescents have very big appetites, and it is important that they should satisfy them with food of high nutritional value containing, particularly, adequate amounts of protein. Milk is a food of great usefulness for adolescents. Adolescents often leave school and home at about the same time. A knowledge of nutrition and its application at this juncture, so that the needs shown in Chapter XIV may be supplied, may easily benefit the health of young people for the rest of their lives.

## FEEDING ADULT WORKERS

In Chapter XIV it has been seen that heavy workers, that is to say, those who need a large number of Calories, do not require, so far as is known, any more protein than anybody else. The hard worker, it seems, does not therefore require extra meat.

The arrangement of meals in different occupations has already been discussed. It depends on the length of the working shift, whether the work is indoors or out-of-doors, and on many other factors. In general, it seems best for the nutrients to be spaced out fairly evenly throughout the day.

An understanding of nutrition is important for the appreciation of diets found in actual practice. An example is given below :

### *Menu for one day for a woman doing moderately active work*

#### *Breakfast*

Porridge (Oatmeal 1 oz.). Milk (4 oz.).  
Baked Kipper (4 oz.).  
Toast (3 oz.). Butter ( $\frac{1}{2}$  oz.).  
Marmalade ( $\frac{3}{4}$  oz.). Tea, Milk (2 oz.). Sugar ( $\frac{1}{2}$  oz.).

10 a.m.

Cup of coffee (5 oz.) at work.

#### *Canteen dinner*

Roast Beef ( $1\frac{1}{2}$  oz.).  
Boiled Potatoes (4 oz.).  
Cabbage (3 oz.).  
Steamed Pudding (3 oz.).  
Custard Sauce (2 oz.).

4 p.m.

Cup of tea (5 oz.). Bun (2 oz.).

## HOW TO PLAN BALANCED MEALS

### Supper

Poached Egg (1). On toast (2 oz. bread).  
Bread (3 oz.). Margarine ( $\frac{1}{2}$  oz.). Jam ( $\frac{1}{4}$  oz.).  
Cake (2 oz.). Orange (4 oz.). Tea (Milk 2 oz., Sugar  $\frac{1}{2}$  oz.).

### 9 p.m.

Cup of Ovaltine (milk 4 oz. plus  $\frac{1}{4}$  oz. Ovaltine).

### *Diet for women doing moderately active work*

Meal			Calo- ries	Pro- tein g.	Fat g.	Cal- cium mg.	Iron mg.	Vita- min A i.u.	Vita- min B <sub>1</sub> mg.	Ribo- flavin mg.	Nico- tinic acid mg.	Vita- min C mg.
Breakfast	7 a.m.	...	773	30.9	28.9	360	3.4	910	0.35	0.65	4.8	4
Snack	10 a.m.	...	53	2.5	2.5	85	0	75	0.03	0.13	0.1	0
Dinner	1 p.m.	...	545	19.3	24.6	203	3.7	351	0.29	0.32	2.8	41
Snack	4 p.m.	...	184	5.1	4.5	48	0.6	20	0.10	0.10	0.6	0
Supper	7 p.m.	...	954	26.2	32.1	335	5.0	1,378	0.50	0.48	2.6	49
Snack	9 p.m.	...	96	4.6	4.5	161	0.3	149	0.08	0.22	0.1	1
Total day's nutrients			2,605	88.6	97.1	1,192	13.0	2,883	1.35	1.90	11.0	95

When the nutrients actually eaten in this diet are compared with the figures in Chapter XIV which show the amounts needed for health, the following can be seen :—

#### *Nutrients Eaten*

#### *Nutrients Needed for Health*

Calories 2,605

Moderately active women need 2,500 Cal. per day so that the amount eaten is the amount needed.

Protein 88.6 g.

Since women need 60 g. protein a day, the amount obtained was fully adequate.

Fat 97.1 g.

$97.1 \text{ fat} = 97.1 \times 9 = 873.9$  Calories. This is 34 per cent of the total Calories eaten. Since when less than 3,000 Cal. are eaten, a reasonable diet can be made when 25 per cent of the Calories are provided by fat, the amount in this diet is sufficient.

Calcium 1.2 g.

This is enough since only 0.8 g. is needed.

Iron 13 mg.

This is enough since only 12 mg. is needed.

Vitamin A 2,883 i.u.

For the best possible diet, the amount of vitamin A needed is 5,000 i.u. daily. A minimum safe figure has been set at 2,500 i.u. so that the amount eaten could be expected at least to prevent ill health.

Vitamin B<sub>1</sub> 1.35 mg.

This is enough since only 1.0-1.2 is needed.

Riboflavin 1.9 mg.

This is enough since only 1.5-1.6 is needed.

Nicotinic acid 11.0 mg.

This is enough since 10-12 mg. is needed.

Vitamin C 95 mg.

Here, although the ideal daily amount needed is 70 mg. a minimum might be set at 15-20 mg., hence the amount eaten is sufficient to safeguard health.

This diet, when compared with many others, is a good one.

## HOW TO FIND OUT WHETHER A DIET IS NUTRITIONALLY GOOD

It is important not only that all nutrients needed should be present in the foods eaten, but also that they should be present in the amounts required by different people.

## MANUAL OF NUTRITION

Thus, in trying to find out whether a particular diet is adequate three things must be known :

- (1) What foods were eaten ?
- (2) How much of each food was eaten ?
- (3) What kind of people ate the foods ? Were they men, women, adolescents, or children, and were they active, very active or sedentary ? Were any of the women pregnant or nursing a baby ?

There are two main ways of finding out about diets, namely, to discover :

- (1) How much food was bought in, say, a week and how many people ate it. If the amount of food bought is recorded, it is important to know how much of it is eaten, how much goes into or comes out of the store-cupboard and how much is wasted in preparing meals and on the plates.
- (2) What weights of foods were eaten by an individual at each separate meal for, say, a week. This is probably one of the most precise methods of assessing the value of a diet. In carrying it out each item of every food must be weighed and recorded.

For meals served by canteens or restaurants it is, of course, possible to weigh all the ingredients of a number of meals as they are ready for serving. An estimate of the amounts of nutrients wasted in preparation can be gained by comparing the calculated nutritional value of the meals served with the calculated nutritional value of the supplies of food coming into the kitchen.

- (3) A third method may be employed by people running canteens who wish to find out what sort of diet their customers eat, so that they may be able to plan meals to complete their nutritional requirements. A selection of the people using the canteen may be interrogated about their previous 24-hours' meals. Whenever an item of food or drink is mentioned, the people being studied must be asked to help themselves to the same amount as they have eaten from a supply which must be available for the interview. This amount is then weighed. From these weighings it is possible to calculate, at least roughly, what sort of diet the people eat and hence what nutritional value the canteen meal can best provide in order that the complete day's food may be adequate for health. (*Warning* : People's memories are so bad that questions ought not to be asked about meals eaten more than 24 hours before.)

### FEEDING THE BEDRIDDEN

When people are in bed, either in hospital or elsewhere, their Calorie needs, and hence the total amount of food they can eat, become very much reduced. It is therefore very easy for a shortage of protein or calcium or some other nutrient to develop. In planning diets for people confined to bed it is important to include :

- (a) Plenty of protein food of high nutritional value, e.g. eggs, fish, milk, etc.
- (b) Plenty of dairy produce to provide calcium, vitamin A and riboflavin.
- (c) Plenty of fruit and vegetables to supply vitamin C.

It is not necessary to give much of foods such as bread and butter, fatty cooked foods, etc., which are rich in Calories.

## HOW TO PLAN BALANCED MEALS

### FEEDING ATHLETES

Provided that an adequate diet is given, there is no certain way of improving athletic performance by means of food. The individual undergoing heavy physical exercise will have a very greatly increased need for Calories, but so long as these are provided, together with the other nutrient requirements set out in Chapter XIV it is, broadly speaking, immaterial in what form the nutrients are supplied.

### FOOD ALLERGIES

The principles set out in this book hold, in general, for all average individuals. There are, however, a few people who possess personal peculiarities. The most dramatic of these peculiarities is a reaction against certain foods. Some people, for example, cannot eat shell fish or strawberries without being ill. Such allergies perhaps present a medical rather than a nutritional problem.

### QUESTIONS ON PART IV

#### *Chapters XVI to XVIII*

1. What effect does cooking have on protein, carbohydrate, vitamin A and vitamin C?
2. What nutritional difference is there between yeast bread and soda bread?
3. Work out the most suitable amounts of nutrients for the following meals :
  - (a) A midday dinner for coal miners who eat bread and dripping for breakfast, bread and cheese in the mine, and fish and chips for tea.
  - (b) A morning snack for girls sorting pins, who have a cup of tea before work, a dinner of sandwiches and for supper cake and spaghetti.
  - (c) A midnight meal for hospital nurses during their three-months' spell of night nursing.
4. Criticise the following meal as a school dinner for children of 14. How could it be improved? Ingredients per 100 meals : 12½ lb. meat, 6½ lb. dried milk, 20 pt. liquid milk, 10 oz. cheese, 1 lb. baked beans, 3 lb. 2 oz. cooking fat, 2½ lb. sugar, 1½ lb. jam, 2 lb. raisins, 2 lb. rice, 1 lb. oatmeal, 10 oz. barley, 6½ lb. flour, 3 lb. bread, 50 lb. potatoes, 3½ lb. dried peas.
5. Five men are planning to spend a fortnight on a yacht out of sight of land. Work out what foodstuffs they should take with them to provide a perfect diet, assuming that the yacht's storage capacity is such that any kind of food can be taken.
6. What are the average daily nutrient requirements per head for a family composed of father, who is a postman ; mother ; grandfather, aged 85 ; John, aged 17 ; Mary, aged 14 ; Matilda, aged 7 ; and Christopher, aged 4½?
7. You are in control of a canteen where it is planned to provide a dinner supplying 800 Cal., at least 24 g. of protein, 200 mg. of calcium, 2,000 i.u. of vitamin A and 25 mg. of vitamin C. Work out three menus :
  - (a) a meal of meat, vegetables and pudding ;
  - (b) a hot meal for vegetarians ;
  - (c) a sandwich meal.
8. Why are fish and chips such an excellent combination?
9. An eccentric wishes to live entirely on sausages and mashed potatoes. What quantity of each must he eat each day if he is an active worker? What other food must he take in order to get a perfect diet?
10. Plan a week's menu, giving quantities, for a hospital containing 100 bedridden men.
11. Discuss the statement 'a little of what you fancy does you good'.

# APPENDIX A

## THE COMPOSITION OF FOOD

### March, 1951

All values are per oz. of edible portion

	Waste Per cent	Calo- ries	Pro- tein g.	Fat g.	Car- bohy- drate (1) g.	Cal- cium mg.	Iron mg.	Vita- min A (2) i.u.	Vita- min B <sub>1</sub> mg.	Ribo- flavin mg.	Nico- tic acid mg.	Vita- min C mg.	Vita- min D i.u.
<b>1. CEREALS</b>													
Barley, pearl, dry ...	0	97	2.2	0.5	20.8	3	0.2	0	0.03	0.01	0.7	0	
Biscuits—													
plain ... ..	0	107	3.4	0.9	21.3	23	0.6	0	0.04	0.03	0.3	0	
sweet ... ..	0	136	2.0	6.8	16.8	14	0.3	0	0.02	0.01	0.2	0	
Bread—													
white 70-72% extraction	0	72	2.3	0.2	15.3	3	0.3	0	0.01	0.01	0.2	0	
national 80% extraction	0	72	2.5	0.3	14.9	30	0.4	0	0.04	0.02	0.3	0	
brown ... ..	0	70	2.5	0.4	14.0	5	0.6	0	0.06	0.03	0.7	0	
Flour—													
white 70-72% extraction	0	97	3.1	0.3	20.5	5	0.4	0	0.02	0.01	0.2	0	
National 80% extr'n(3)	0	97	3.4	0.4	19.9	41	0.5	0	0.07	0.02	0.5	0	
brown ... ..	0	95	3.4	0.7	18.8	8	0.9	0	0.10	0.04	1.3	0	
Oatmeal ... ..	0	111	3.4	2.5	18.6	16	1.2	0	0.13	0.04	0.3	0	
Rice ... ..	0	99	1.8	0.3	22.2	1	0.1	0	0.02	0.02	0.3	0	
Wheatflakes, Shred. Wheat	0	97	3.9	0.7	18.7	10	1.4	0	0.01	0.02	0.3	0	
<b>2. DAIRY PRODUCTS</b>													
Butter ... ..	0	211	0.1	23.4	0	4	Trace(4)	1134	0	0	0	0	17
Cheese, Cheddar ...	5 (rind)	117	7.1	9.8	0	230	0.2	369	0.01	0.14	0.1	0	4
Egg—fresh ... ..	12	45	3.5	3.3	0.3	17	0.9	284	0.04	0.11	Trace(4)	0	17
dried ... ..	0	163	13.0	11.9	0.9	62	3.1	852	0.11	0.30	0.1	0	68
Milk—whole ... ..	0	17	0.9	1.0	1.2	34	Trace(4)	32	0.01	0.04	Trace(4)	0.3	0
evaporated, condensed, unsweetened ...	0	46	2.4	2.6	3.3	83	0.1	105	0.02	0.10	0.1	0.6	1
condensed, whole sweet- ened ... ..	0	89	2.3	2.6	14.1	82	0.1	105	0.03	0.10	0.1	0.9	1
condensed, skimmed, sweetened ... ..	0	75	2.7	0.1	15.8	91	0.1	6	0.04	0.14	0.1	0.9	0
dried, whole ... ..	0	135	7.7	7.4	9.5	254	0.2	304	0.09	0.33	0.2	2	280
dried, skimmed ...	0	97	10.2	0.2	13.6	348	0.3	9	0.11	0.45	0.3	2	0
<b>3. FATS</b>													
Cooking fat, lard, etc. ...	0	253	0	28.1	0	0	0	0	0	0	0	0	0
Margarine ... ..	0	218	0	24.2	0	1	0.1	500	0	0	0	0	90
<b>4. FISH</b>													
Kippers ... ..	40	62	5.4	4.5	0	34	0.6	51	0	0.09	1.2	0	250
White fish, cod, etc. ...	45	19	4.5	0.1	0	7	0.3	0	0.02	0.04	0.6	0	0
Fried fish (white) ...	0	57	5.3	3.4	1.4	24	0.3	0	0.02	0.03	0.4	0	0
Fish paste ... ..	0	47	3.8	2.5	2.2	41	1.7	0	0.01	0.02	0.3	0	0
Herring ... ..	30	48	4.5	3.3	0	28	0.4	43	0	0.08	1.0	0	250
Salmon, canned ... ..	0	48	5.7	2.8	0	85	0.4	71	0.03	0.06	1.8	0	170
Sardine, canned ... ..	0	84	5.7	6.8	0	114	1.1	77	0.01	0.08	1.3	0	280
<b>5. MEAT</b>													
Bacon ... ..	12	128	3.1	12.8	0	3	0.3	0	0.17	0.03	1.1	0	0
Beef—													
corned ... ..	0	69	7.1	4.5	0	3	3.1	0	0	0.04	0.5	0	0
fresh, av. good quality	17	89	4.2	8.0	0	3	1.1	14	0.02	0.07	1.3	0	0
stewing ... ..	25	60	4.8	4.5	0	3	1.1	14	0.02	0.07	1.3	0	0
Kidney ... ..	0	36	4.5	2.0	0	3	3.8	284	0.07	0.37	3.8	0	0
Liver, ox ... ..	0	40	4.8	1.7	1.4	3	3.9	4,253	0.11	0.85	3.8	0	0
Meat pie ... ..	0	81	2.4	5.7	5.1	12	0.5	61	0.02	0.02	0.3	0	0
Meat paste ... ..	0	45	3.4	2.3	2.6	7	0.5	0	0.01	0.03	0.6	0	0
Mutton ... ..	17	94	3.7	8.8	0	3	0.6	14	0.05	0.05	1.2	0	0
Lunch meat, canned ...	0	71	4.3	6.0	0	3	0.6	0	0.13	0.04	0.7	0	0
Pork ... ..	15	115	3.4	11.3	0	3	0.3	0	0.20	0.06	1.7	0	0
Sausage, pork ... ..	0	82	2.6	6.1	4.2	17	0.1	0	0.05	0.01	0.5	0	0
Shepherd's pie, etc. ...	0	41	2.1	2.5	2.6	3	0.4	8	0.02	0.03	0.4	1	1

(1) Expressed as starch.

(2) The letter c after the value indicates that the sole source of vitamin A potency is carotene.

(3) National flour and national flour products show the calcium content after the addition of chalk to the flour at the rate of 14 oz. calcium carbonate per 280 lb. flour.

	Waste Per cent	Calo- ries	Pro- tein g.	Fat g.	Car- bohy- drate (1) g.	Cal- cium mg.	Iron mg.	Vita- min A (2) i.u.	Vita- min B <sub>1</sub> mg.	Ribo- flavin mg.	Nico- tinic acid mg.	Vita- min C mg.	Vita- min D i.u.
<b>VEGETABLES</b>													
Beans—baked, canned ...	0	25	1.7	0	4.5	16	0.7	142c	0.02	0.01	0.2	1	0
Haricot ...	0	71	6.1	0	11.6	51	1.9	0	0.13	0.08	0.6	0	0
French beans ...	5	4	0.3	0	0.7	9	0.2	170c	0.02	0.03	0.1	3	0
Cabbage ...	30	7	0.4	0	1.4	18	0.3	255c	0.02	0.02	0.1	20	0
Carrots ...	5-20	6	0.2	0	1.4	14	0.2	5,197c	0.02	0.01	0.2	3	0
Cauliflower ...	30	6	0.7	0	0.9	14	0.3	0	0.03	0.02	0.2	20	0
Centil ...	0	81	6.7	0	13.6	11	2.2	14c	0.13	0.02	0.9	0	0
Lettuce ...	20	3	0.3	0	0.5	7	0.2	1,134c	0.02	0.02	0.1	4	0
Onion ...	5	6	0.3	0	1.3	9	0.1	0	0.01	0.01	Trace(4)	3	0
Peas, green ...	60	17	1.6	0	2.7	4	0.5	142c	0.12	0.03	0.2	9	0
Dried ...	0	84	6.9	0	14.2	17	1.3	57c	0.13	0.08	0.6	0	0
Potato, fresh ...	7-25	21	0.6	0	4.6	2	0.2	0	0.03	0.02	0.3	9(5)	0
Chips ...	0	66	1.1	2.6	9.5	4	0.4	0	0.02	0.01	0.2	1	0
Spinach ...	25	6	0.8	0	0.7	20	0.9	3,686c	0.03	0.06	0.1	18	0
Tomato ...	15	4	0.3	0	0.7	4	0.1	851c	0.02	0.01	0.1	7	0
Turnip ...	35	5	0.2	0	1.0	17	0.1	0	0.01	0.01	0.3	7	0
Watercress ...	15	4	0.8	0	0.2	63	0.5	1,418c	0.03	0.02	0.5	17	0
<b>FRUIT</b>													
Apple—fresh ...	20	12	0.1	0	3.0	1	0.1	11c	0.01	0	0.1	1	0
Dried ...	0	52	0.6	0	12.5	9	0.6	28c	0	0.01	0.4	0	0
Apricot—fresh ...	8	8	0.2	0	1.7	5	0.1	213c	0.01	0.02	0.1	3	0
Canned ...	0	14	0.1	0	3.5	4	0.1	142c	0.01	0.02	0.1	1	0
Dried ...	0	50	1.4	0	11.1	26	1.2	1,418c	0	0.12	0.6	0	0
Banana ...	40	21	0.3	0	4.9	2	0.1	23c	0.01	0.01	0.2	3	0
Blackcurrant ...	0	8	0.3	0	1.7	17	0.4	26c	0.01	0.01	0.1	57	0
Date ...	14	68	0.6	0	16.3	19	0.5	28c	0	0.01	0.1	0	0
Fig, dried ...	0	58	1.0	0	13.5	81	1.2	26c	0	0.08	0.5	0	0
Lemon(6) ...	64	0	0	0	0.1	1	Trace(4)	0	0	0	0	5	0
Melon ...	45	6	0.2	0	1.3	4	0.1	24c	0.01	0.01	0.2	3	0
Orange ...	25	10	0.2	0	2.2	12	0.1	85c	0.02	0.01	0.1	16	0
Peach—fresh ...	13	10	0.2	0	2.3	1	0.1	213c	0.01	0.01	0.2	3	0
Canned ...	0	16	0.1	0	3.9	2	0.2	142c	0	0	0.1	1	0
Pear ...	25	11	0.1	0	2.7	2	0.1	3c	0.01	0.01	0.1	1	0
Pineapple, canned ...	0	20	0.1	0	4.9	3	0.2	18c	0.01	0.01	0.1	3	0
Plums, fresh ...	6	9	0.2	0	2.0	4	0.1	113c	0.01	0.01	0.2	1	0
Canned ...	0	20	0.1	0	4.8	4	0.4	55c	0.01	0	0.1	1	0
Prune ...	17	44	0.7	0	10.3	11	0.8	709c	0	0.04	0.6	0	0
Raisin ...	8	67	0.3	0	16.4	17	0.5	14c	0	0.01	0.1	0	0
<b>8. NUTS</b>													
Coconut ...	30	100	1.1	10.2	0.9	4	0.6	0	0.03	0	0.1	0	0
Peanut ...	30	166	8.0	13.9	2.2	17	0.6	0	0.26	0.08	0.6	0	0
Soya flour... ..	0	121	11.5	6.6	3.8	62	2.0	0	0.19	0.04	1.0	0	0
<b>9. PRESERVES, ETC.</b>													
Chocolate, plain ...	0	148	1.3	9.2	15.0	7	0.9	21c	0.03	0.07	0.3	0	0
Jam ...	0	71	0.1	0	17.6	3	0.3	6c	0	0	0	1	0
Sugar ...	0	108	0	0	27.0	0	0	0	0	0	0	0	0
Syrup ...	0	81	0.1	0	20.2	7	0.4	0	0	0	0	0	0
Honey ...	0	78	0.1	0	19.5	1	0.1	0	0	0.02	0.1	0	0
<b>10. BEVERAGES</b>													
Beer ...	0	10	0.1	0.1	0.5	3	0	0	0	0.01	0.4	0	0
Cocoa, as drunk with milk and sugar ...	0	25	1.1	1.2	2.4	36	0.1	42	0.01	0.04	Trace(4)	0	1
powder ...	0	125	5.8	7.3	8.9	14	4.1	43c	0.03	0.08	0.3	0	0
Tea, as drunk with milk and sugar ...	0	5	0.1	0.1	0.8	5	Trace(4)	4	0	0.01	Trace(4)	0	0
<b>11. CAKES AND PUDDINGS</b>													
Cake, plain ...	0	117	2.4	5.4	14.8	24	0.4	154	0.04	0.04	0.2	0	21
Bun ...	0	82	2.3	2.0	13.6	14	0.3	0	0.04	0.03	0.3	0	0
Custard ...	0	31	0.9	1.1	4.5	35	Trace(4)	30	0.01	0.03	Trace(4)	0	0
Rice pudding ...	0	46	1.3	2.0	5.7	41	Trace(4)	52	0.02	0.05	Trace(4)	0	3
Steamed pudding ...	0	86	1.1	4.4	10.6	15	0.2	0	0.02	0.01	0.1	0	0
Yorkshire pudding ...	0	57	2.0	2.7	6.4	37	0.2	6	0.03	0.05	0.2	0	3

(4) Present, but in quantities of 0.05 or less.

(5) The vitamin C content falls steadily during the months of storage.

(6) As purchased plus the rind. Vitamin C content of edible portion would be 14 mg. per oz.

## APPENDIX B

The following books, periodicals and pamphlets are recommended for supplementary reading :

<i>Text-books</i>	<i>Author</i>	<i>Publisher</i>	<i>Price</i>
The Vitamins in Medicine	F. Bicknell and F. Prescott	William Heinemann Medical Books Ltd.	50s.
Report of the Committee on Nutrition	British Medical Association	British Medical Association	7s. 6d.
Cooking and Nutritive Value	A. Barbara Callow	Oxford University Press	7s. 6d.
A Textbook of Dietetics	L. S. P. Davidson and Ian A. Anderson	E. & S. Livingstone, Ltd., Edinburgh	21s.
Nutrition and Diet in Health and Disease	J. S. McLester	W. B. Saunders & Co.	45s.
Hutchison's Food and the Principles of Dietetics	V. H. Mottram and George Graham (eds)	Edward Arnold & Co.	25s.
Human Nutrition	V. H. Mottram	Edward Arnold & Co.	11s.
Modern Methods of Feeding in Infancy and Childhood	Donald Paterson and J. Forest Smith	Constable	10s.
The Foundations of Nutrition	Mary Swartz Rose	Macmillan & Co., New York	36s.
The Chemistry of Food and Nutrition	Henry C. Sherman	Macmillan & Co., New York	41s.
Essentials of Nutrition	H. C. Sherman and C. S. Lanford	Macmillan & Co., New York	32s.
<i>Journals</i>	<i>Date of Issue</i>	<i>Publisher</i>	<i>Price</i>
Nutrition	Quarterly	Newman Books Ltd.	2s. 6d.
Ministry of Food Bulletin	Weekly	H.M. Stationery Office	6d.
Better Health	Bi-Monthly	Central Council for Health Education, Tavistock House Tavistock Square, London, W.C.1.	by Post, 7½d. By Annual Subscription 4s. 6d.
Nutrition Reviews	Monthly	Nutrition Foundation Inc., Chrysler Building, New York, 17, N.Y.	4.50 Dollars, p.a.
<i>Food Tables</i>	<i>Author</i>	<i>Publisher</i>	<i>Price</i>
The Chemical Composition of Foods	R. A. McCance and E. M. Widdowson	Medical Research Council, Special Report Series, No. 235, His Majesty's Stationery Office, 1946.	6s.
Nutritive Values of Wartime Foods		Medical Research Council, War Memorandum, No. 14, His Majesty's Stationery Office, 1945.	1s.
Composition of Foods— Raw, Processed, Prepared	B. K. Watt and A. L. Merrill	United States Department of Agriculture, Agriculture Handbook, No. 8, 1950.	2s. 6d.



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